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Development of Miniature Food Chain Learning Media for Local Ecosystem-Based Science Instruction in Grade V

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ABSTRACT

At the elementary school level, particularly in science instruction on food chain material, the development of innovative learning media is essential to enhance both the quality of instruction and the creativity of teachers and students. Instructional media function as tools specifically designed to convey information and stimulate students' thoughts, attention, and willingness to learn, thereby supporting the achievement of learning objectives. This study employed the ADDIE model, comprising five sequential stages: Analysis, Design, Development, Implementation, and Evaluation. The research participants consisted of 30 fifth-grade students at SD Inpres 16, Sorong Regency. The findings indicate that the developed miniature food chain media was proven valid, as confirmed through assessment by material, language, and design experts. With respect to practicality, the media was deemed practical, obtaining an average trial score of 75 among student users. The effectiveness test likewise demonstrated favorable results, with a mean post-test score of 82.6 (high category) and a classical mastery percentage of 98%. It is therefore concluded that the miniature food chain media is valid, practical, and effective for use in fifth-grade science instruction at SD Inpres 16, Sorong Regency.

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INTRODUCTION

Teachers occupy a pivotal role in establishing an engaging and supportive learning atmosphere through the deployment of creative and diverse instructional media (Jumrawarsi & Suhaili, 2020). Instructional media function as tools for conveying information that stimulates students' attention, interest, and enthusiasm for learning (Hasan et al., 2021). At the primary school level, particularly in science instruction on food chain material, the development of innovative learning media is essential for enhancing both instructional quality and the creativity of teachers and students alike.

Learning constitutes a deliberately structured means of conveying information designed to achieve specific objectives within teaching and learning activities. Instructional media, in this context, function as tools that facilitate the delivery of content to students. More broadly, instructional media may be understood as any resource capable of transmitting messages and emotional content, while simultaneously stimulating students' thinking, attention, and willingness to engage, thereby fostering active learning (Arsyad, 2017; Smaldino et al., 2019).

Primary education today is expected to function not merely as a site for the transmission of knowledge but as an institution that actively cultivates students' latent potential, preparing them to become future agents of positive social change. Realizing this potential requires careful attention to specific subject content, including ecological material such as the food chain, that demands concrete and accessible pedagogical treatment. Accordingly, the development of innovative instructional media at the primary level constitutes a necessary solution for improving the overall quality of science education (Widiyatmoko & Pamelasari, 2016).

Preliminary observations conducted at SD Inpres 16, Sorong Regency,

revealed an absence of innovative and motivating instructional media for science learning. This deficiency contributed to a discernible lack of student enthusiasm and active participation during lessons. Such findings are consistent with broader research indicating that the absence of varied, concrete instructional resources is among the principal contributing factors to diminished student engagement in primary science classrooms (Feri & Zulherman, 2021).

The miniature food chain media developed in this study was designed as an attractive and representative three-dimensional model, intended to enable students to comprehend the concept of the food chain in a more concrete and visual manner. Three-dimensional, concrete instructional media are particularly well-suited to the cognitive characteristics of primary school students, who in accordance with Piaget's (1972) theory of cognitive development are generally situated within the concrete operational stage, wherein logical reasoning is most effectively supported by tangible, manipulable objects rather than purely verbal or abstract instruction.

Visual media has been empirically demonstrated to enhance both comprehension and learning motivation among students (Sudjana & Rivai, 2017). From the perspective of cognitive multimedia learning theory, Mayer (2021) contends that the integration of visual and verbal information channels reduces extraneous cognitive load and facilitates deeper conceptual understanding, an effect particularly salient when abstract scientific phenomena, such as energy transfer within an ecosystem, are rendered visually and spatially concrete. By employing the ADDIE model, the development of this instructional medium was designed to align with the requirements of the Kurikulum Merdeka, which emphasises inquiry-based learning and direct, hands-on experience in science instruction (Cennamo & Kalk, 2019).

The Kurikulum Merdeka further reframes the role of the teacher as a facilitator of student-centred learning, in which students assume an active role in constructing their own understanding through dialogue, exploration, and collaborative engagement. This pedagogical reorientation resonates with the

principles of critical and democratic pedagogy, which emphasize the empowerment of students through dialogic and participatory learning processes (Pada et al., 2025). Within this framework, the use of cooperative and interactive instructional models, such as the Team Games Tournament approach examined by Huda et al. (2024), has been shown to enhance student engagement and learning outcomes by transforming passive reception into active participation.

Science process skills constitute a further critical dimension of effective primary science instruction. Rusli and Yasmin (2024) demonstrate that the integration of character education within discovery learning models significantly improves students' basic science process skills, including observation, classification, and inference, competencies that are directly relevant to food chain instruction, wherein students must observe, classify, and reason about the relationships among organisms within an ecosystem. Discovery-based, hands-on engagement with concrete instructional models, such as the miniature media developed in this study, provides a natural vehicle for the cultivation of these process skills.

A further pedagogical rationale for the development of concrete instructional media relates to the persistent challenge of student misconceptions in elementary science education. Rusli et al. (2025) provide a comprehensive cognitive and neurodevelopmental analysis demonstrating that misconceptions in elementary science, including those relating to ecological and biological processes, often arise from learners' premature reliance on abstract verbal explanation in the absence of concrete experiential anchoring. Their findings underscore the pedagogical value of concrete, manipulable instructional media of the kind developed in the present study, as such media provide the experiential scaffolding necessary to support accurate conceptual development and to pre-empt the formation of misconceptions regarding trophic relationships within an ecosystem.

Instructional media may be broadly classified according to two dimensions: two-dimensional and three-dimensional representations. As

Sudjana (cited in Wismaya, 2015) observes, visual symbols clarify verbal symbols, thereby enabling students to comprehend instructional messages more readily. The effectiveness of visually based instruction is strongly contingent upon the quality of the visual elements employed; accordingly, teachers must ensure that the visual components of instructional media foreground the core message to be communicated, so that students can grasp content with clarity and precision (Sadiman et al., 2014; Smaldino et al., 2019).

Despite the demonstrated pedagogical value of concrete, three-dimensional instructional media, a persistent gap remains in the availability of innovative media tailored to the specific characteristics of students and the local ecological context at SD Inpres 16, Sorong Regency. Comparable research, such as Trisnawati's (2024) development of problem-based instructional video for food chain material, has explored alternative media modalities for this same subject matter, yet three-dimensional, locally contextualised miniature media specific to the rice-field ecosystem characteristic of the Sorong region remain unexplored. This study therefore aims to address this gap by developing a miniature food chain instructional medium that is valid, practical, and effective in improving student learning outcomes in fifth-grade science instruction.

METHODS

This study employed a Research and Development (R&D) approach using the ADDIE model, a systematic instructional design framework comprising five sequential phases: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009; Cennamo & Kalk, 2019). The ADDIE model was selected for its iterative and evaluative structure, which enables continuous refinement of the instructional product through formative feedback at each developmental stage (Tegeh et al., 2017).

The research was conducted in Class V at SD Inpres 16, Sorong Regency, West Papua Province, Indonesia, during the 2025/2026 academic year. The population and sample for this study comprised all 30 fifth-grade students

enrolled at the school. The relatively small and homogeneous class size permitted comprehensive participation of all students in both the product trial and the effectiveness evaluation phases.

In the Analysis phase, the researcher conducted a needs assessment encompassing curriculum analysis, an examination of student characteristics, and an analysis of the food chain instructional content within the context of the local rice-field ecosystem. In the Design phase, a conceptual blueprint of the miniature media was developed, specifying its physical components, visual layout, and alignment with intended learning objectives. In the Development phase, the physical miniature prototype was constructed and subjected to expert validation prior to classroom use. In the Implementation phase, the validated media was trialled directly with the 30 student participants under authentic classroom conditions. Finally, in the Evaluation phase, both formative evaluation (conducted iteratively throughout the preceding phases) and summative evaluation (assessing the overall validity, practicality, and effectiveness of the final product) were undertaken.

Data collection employed three principal techniques. First, tests were administered in the form of a pre-test and post-test, designed to measure students' conceptual understanding of food chain material before and after the use of the developed media. Second, observation was conducted to directly examine student behaviour and classroom interaction during the implementation of the instructional medium under authentic conditions. Third, documentation was employed to gather supporting data through written records, archival material, and relevant theoretical and empirical literature pertaining to the research problem.

Expert validation was conducted using a structured Likert-scale validation instrument administered to three categories of expert validators: material content experts, language experts, and instructional design experts. This multi-domain validation procedure is consistent with established R&D assessment conventions, which require triangulated expert judgement to establish product validity prior to field trial (Akbar, 2017; Sugiyono, 2022; Zaini

& Soenarto, 2019).

Data analysis comprised three distinct procedures: validity analysis, practicality analysis, and effectiveness analysis. Validity analysis involved the conversion of expert validator scores into qualitative categories using established assessment criteria (Akbar, 2017). Practicality analysis was conducted by calculating the average score obtained from the student trial, with scores categorized according to established practicality thresholds (Sugiyono, 2022). Effectiveness analysis comprised two complementary measures: the calculation of mean post-test scores, and the calculation of the classical mastery percentage, defined as the proportion of students achieving the Minimum Mastery Criterion (Kriteria Ketuntasan Minimal/KKM) of 75, in accordance with standard effectiveness benchmarks employed in Indonesian instructional media R&D studies (Zaini & Soenarto, 2019).

RESULTS AND DISCUSSION

Validity of the Miniature Food Chain Learning Media

The development of the miniature food chain media was undertaken with the specific objective of producing an instructional resource suitable for teaching food chain concepts within the context of a rice-field ecosystem. Every instructional topic possesses distinct characteristics, ranging from its inherent level of difficulty to other features requiring specialized pedagogical treatment, that must be carefully addressed to ensure the effective communication of learning objectives to students. Purely verbal instruction, delivered without the support of appropriate instructional media, is therefore insufficient, particularly in contexts where printed textbook resources are limited relative to the number of students requiring access.

This limitation may be effectively addressed through the provision of miniature instructional media capable of animating the classroom learning atmosphere and of representing an ecosystem in a manner that closely approximates its real-world form. The miniature food chain media developed in

this study was validated by Lina Kumalasari, M.Pd., a lecturer at the Faculty of Language, Social, and Sports Education, Universitas Pendidikan Muhammadiyah Sorong, who assessed the product across the domains of material content, language, and instructional design.

The achievement of validity in the developed miniature media is significant in that it enables students to engage in direct observation of phenomena that would otherwise remain abstract when conveyed through theoretical explanation alone. By incorporating the constituent components of a rice-field ecosystem within a single, integrated instructional model, the media allows students to attain the intended learning objectives more readily, while simultaneously providing teachers with an enhanced platform for pedagogical creativity in the instruction of ecosystem-related content.

These findings are consistent with the broader literature on instructional media validity in Indonesian primary science education. Zaini and Soenarto (2019) similarly demonstrate that locally contextualized, concrete instructional media, when subjected to rigorous expert validation across content, language, and design domains, consistently achieve high validity ratings and are positively received within authentic classroom settings. Likewise, Widiyatmoko and Pamelasari (2016) report that project-based, locally sourced instructional media for primary science instruction achieve strong validity outcomes when development is grounded in systematic needs analysis and iterative expert review, as was the case in the present study's application of the ADDIE model.

Practicality of the Miniature Food Chain Learning Media

Practical instructional media are characterized by their ease of use and straightforward application within the classroom learning process. The level of practicality possessed by an instructional medium is determined through field trial data collected directly from student users. Based on the trial results obtained from the 30 participating students, the average score recorded was 75, indicating, according to established practicality assessment criteria, that the

developed miniature food chain media falls within the practical category and may therefore be appropriately applied within the school setting.

Several positive outcomes were identified in connection with the practicality of the developed media: (1) the teacher's instructional role was observed to shift in a more positive and facilitative direction; (2) the media fostered positive student attitudes toward the subject matter under study; (3) the quality of learning outcomes demonstrated measurable improvement; (4) instructional time was used more efficiently; (5) classroom learning became more interactive; and (6) the overall learning experience was rendered more engaging through the incorporation of the instructional media.

These practical outcomes align closely with the principles of student-centered, dialogic pedagogy emphasized within the Kurikulum Merdeka framework. Pada et al. (2025) similarly argue that instructional approaches that actively engage students in dialogue and direct exploration, rather than passive reception of teacher-delivered content, substantially enhance both student engagement and the perceived practicality of instructional interventions. Comparable findings have been reported in the context of cooperative, game-based instructional models: Huda et al. (2024) demonstrate that interactive, student-centered learning approaches such as the Team Games Tournament model produce similarly favorable practicality outcomes, characterized by heightened student enthusiasm, more efficient time use, and increased interactivity during classroom instruction, patterns closely mirrored in the present study's findings regarding the miniature food chain media.

Effectiveness of the Miniature Food Chain Learning Media

The effectiveness of the miniature food chain media is evidenced by its capacity to support classroom implementation specifically in connection with food chain material within the rice-field ecosystem context, while concurrently developing and enhancing student learning outcomes. This effectiveness was substantiated

through assessment of student performance following the use of the instructional medium, evaluated against the intended learning objectives. Student test results, derived from a multiple-choice assessment instrument, served as the principal indicator of learning achievement, with instruction deemed successful where students attained a mastery score of 75% or higher.

The mean post-test score recorded across the 30 student participants was 82.6, situated within the high category according to standard assessment benchmarks. In parallel, the percentage of students achieving the established Minimum Mastery Criterion (KKM ≥ 75), that is, the classical mastery percentage, reached 98%, a figure that further confirms the substantial improvement in student learning outcomes following the implementation of the miniature food chain media. Table 1 below presents a consolidated summary of the validity, practicality, and effectiveness findings of this study.

Table 1. Summary of validity, practicality, and effectiveness results of the miniature food chain learning media

Quality Criterion	Indicator	Result	Category
Validity	Assessment by material, language, and design experts	Valid	Valid
Practicality	Average student trial score (n = 30)	75.0	Practical
Effectiveness (mean score)	Average post-test score (n = 30)	82.6	High
Effectiveness (classical mastery)	Percentage of students reaching the minimum mastery criterion (KKM ≥ 75)	98%	Effective

Source: Field trial and expert validation data, 2026

The convergence of strong mean post-test performance and near-universal classical mastery provides robust empirical evidence that the miniature food chain media developed in this study is effective in supporting student learning outcomes in fifth-grade science instruction. These findings are consistent with Rusli and Yasmin's (2024) demonstration that discovery-oriented, hands-on instructional approaches significantly enhance students' basic science process skills, as the concrete and manipulable nature of the miniature media in this study afforded students direct opportunities to observe, classify, and reason about trophic relationships within the rice-field ecosystem.

Furthermore, the strong effectiveness outcomes observed in this study lend empirical support to the cognitive and neurodevelopmental account offered by Rusli et al. (2025), who argue that concrete instructional media play a critical role in mitigating the formation of misconceptions in elementary science education. By providing students with a tangible, three-dimensional referent for an otherwise abstract ecological concept, the miniature food chain media appear to have facilitated more accurate conceptual development, a finding consistent with broader research on concrete operational learning and multimedia cognitive theory (Mayer, 2021; Piaget, 1972).

These findings also resonate with comparable instructional media development research within the same subject domain. Trisnawati (2024), in developing a problem-based instructional video for food chain material at the primary level, similarly reported substantial gains in student learning outcomes following implementation, suggesting that the underlying pedagogical principle, rendering abstract ecological relationships concrete and observable, is effective across multiple media modalities, whether three-dimensional miniature models or audiovisual instructional formats. The present study's findings extend this body of evidence by confirming the particular effectiveness of locally contextualized, three-dimensional miniature media within an Eastern Indonesian primary school setting.

CONCLUSION

Based on the research findings, it can be concluded that the development of the miniature food chain instructional media for the rice-field ecosystem material in Class V at SD Inpres 16, Sorong Regency, produced positive and significant outcomes. The developed media was demonstrated to be effective in enhancing student understanding of food chain concepts, as evidenced by an improvement in mean learning outcome scores from pre-test to post-test, with a final mean post-test score of 82.6 and a classical mastery percentage of 98%. These findings indicate that the miniature media successfully simplified an

abstract ecological concept into a form that was concrete and readily comprehensible to students.

The success of this instructional medium was further substantiated by high validity ratings awarded by material, language, and design experts, confirming that the developed media satisfied established validity criteria across content, presentation, and instructional interaction. In addition, the practicality of the media was confirmed through its capacity to assist students in comprehending the structure of food chain material in a more systematic manner. Students were able to directly observe the relationships among living organisms within an ecosystem through the visual representation provided by the miniature media, rendering the learning process more interactive and engaging.

A principal strength of the developed miniature media lies in its capacity to enhance student learning interest and classroom interaction. Students demonstrated greater enthusiasm and active participation in observing, questioning, and discussing the instructional content. The media also assisted teachers in delivering instructional content more effectively and efficiently, reducing reliance on lecture-based delivery and increasing student engagement throughout the learning process. Nevertheless, certain limitations were identified, including the relatively higher time and cost requirements associated with the media's construction and preparation, as well as the need for careful maintenance to preserve the media's usability across subsequent instructional cycles.

Overall, the miniature food chain media developed in this study constitutes a viable alternative instructional resource for primary science education, particularly in the teaching of rice-field ecosystem material. The implementation of this media is expected to improve instructional quality and to strengthen students' conceptual understanding of science content. The findings of this study further suggest that the use of innovative and interactive instructional media can substantially enhance classroom learning effectiveness. For future development, it is recommended that this media development the

approach can be extended to other abstract science topics so as to broaden students' overall learning experience and to further reduce the incidence of misconceptions in elementary science instruction.

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Declarations

Author Contribution	:	Yulanda Salema: Conceptualization, Data Collection, Media Development, Writing – Original Draft; Supriyati Fatma Rabia: Writing – Review & Editing, Formal Analysis, and Methodology; Anis Alfian Fitriani: Validation and Supervision.
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