



## Local infographics enhance critical thinking and conceptual understanding in biology education

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### ABSTRACT

This study addresses the persistent challenge of low critical thinking skills and inadequate conceptual understanding among junior high school students in science, particularly concerning ecology and biodiversity topics that require contextual relevance. The core gap identified is the lack of integration of contextually relevant and visually engaging teaching materials to support the development of these competencies. The research aimed to develop, validate, and evaluate the effectiveness of infographic-based learning media that integrates local environmental issues to enhance these two competencies in Grade VII students. Employing a Research and Development (R&D) approach, the study utilized the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to systematically design and test the learning product. The implementation phase used a One-Group Pre-test-Post-test Design involving 17 students from a public junior high school located in Gorontalo Regency, Gorontalo Province. The developed media achieved an average expert validation score of 93.74% (Very Valid Category), confirming its quality. Effectiveness analysis using the Normalized Gain (N-Gain) score demonstrated significant improvement in student outcomes: the N-Gain for critical thinking was 0.72 (High Category), and for conceptual understanding, it was 0.77 (High Category). Furthermore, the media was highly practical, with student responses showing an overwhelming 98.1% positive feedback. Given the demonstrated high levels of validity, practicality, and effectiveness, the use of infographic-based learning media that connects abstract scientific concepts with local environmental contexts is proven to be a robust resource for fostering students' critical thinking skills and conceptual mastery in biology education.

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## INTRODUCTION

Education in the 21st century places a paramount demand on fostering critical thinking skills (Facione, 2015; López et al., 2023; Arda et al., 2024) and strengthening conceptual understanding (Ahmad, 2020). These two competencies are globally recognized as the essential foundation for adequately preparing students to effectively address and navigate the complex, rapidly evolving dynamics of the modern world (Tang et al., 2024). This pedagogical shift emphasizes equipping students with intellectual tools that enable deeper engagement with information rather than mere acquisition.

The necessity for these high-level competencies is amplified within the domain of science education, particularly in subjects such as ecology and biodiversity. In this field, these skills are crucial because students are expected to transcend rote memorization. They must be able to deeply understand complex concepts, analyze and evaluate the intricate interrelationships among various organisms, and critically assess the significant impact of human activities on fragile ecosystems (Fajari et al., 2020; Partono et al., 2021). Furthermore, this rigorous expectation explicitly aligns with the goals of developing Higher-Order Thinking Skills (HOTS), as highlighted in current educational frameworks (Anderson & Krathwohl, 2001).

Despite these global demands, the enhancement of critical thinking and conceptual mastery remains a persistent challenge, nationally and globally. National data consistently points to deep deficiencies in higher-order cognitive abilities, evidenced by Indonesia's consistently low rankings in international assessments such as PISA, where the 2018 results placed Indonesia 70th out of 78 participating countries in science literacy (OECD, 2019), underscoring the urgency for pedagogical innovation to move beyond rote learning. This deficiency is often rooted in traditional, teacher-centered learning processes that fail to effectively cultivate critical thinking and analytical reasoning. Therefore, there is a pressing need to develop learning materials and instructional strategies that prioritize active student engagement and the application of knowledge to real-world contexts. Effective learning requires bridging abstract concepts with tangible, real-world contexts, especially concerning environmental issues immediately relevant to students' lives. To significantly enhance student engagement, implementing a Place-Based Education (PBE) approach is highly recommended, as it strategically utilizes local contexts as the basis for learning (Hamilton, 2023; Benedicto & Andrade, 2022). Student involvement naturally increases when educational content is directly linked to local problems, such as deforestation, water pollution, or species loss observed in their surrounding environment (Traboco et al., 2022).

A similar condition was identified at a specific public junior high school in Gorontalo Regency. Initial observations revealed that students struggled to understand the connection between ecological concepts and their surrounding environmental realities. The existing teaching materials were limited to verbal and visual delivery that did not sufficiently represent local conditions. Consequently, students tended to be passive in class discussions, rarely posed questions, and were not yet able to analyze environmental issues using a critical thinking approach (Kurnia & Caswita, 2020; Lusiana et al., 2020). The core gap identified is the lack of integration of contextually relevant and visually engaging teaching materials to support the development of critical thinking and conceptual understanding.

One potential alternative lies in the use of infographics. By integrating text, images, and data in a structured visual format (Chicca & Chunta, 2020), infographics can simplify complex concepts into more accessible forms, while also stimulating students' critical thinking through the presentation of contextual information (Provvidenza et al., 2019). Effective infographic design, as a multisensory learning tool (Nkosinkulu, 2024), encourages active and constructive information processing (Chi, 2009; Beecher et al., 2023). The utilization of infographics aligns with contextual learning approaches that emphasize students' active knowledge construction through meaningful learning experiences. Several previous studies (Blackburn, 2019; Ozdamli et al., 2016) have demonstrated the effectiveness of infographics, including their utility in producing scientific outputs (Blackburn, R. A. R., 2019; Arochman et al., 2023; Elaldi & Çifçi, 2021).

However, research on media development has rarely systematically combined infographic media with local environmental issues to simultaneously evaluate the impact on both critical thinking skills and conceptual understanding, particularly within the context of ecology and biodiversity in this region (Muhyiddin et al., 2023). This systematic integration of visual design (infographics), place-based context, and a dual-competency focus represents the novelty and unique contribution of the learning product developed in this study.

Therefore, this research employed the ADDIE development model (Branch, 2009; Molenda, 2015) to systematically create, validate, and test this innovative learning media designed to address the gap identified at the research location. The specific objectives of this research were: (1) to describe the validity of infographics based on local environmental issues for enhancing students' critical thinking skills and conceptual understanding; (2) to describe the practicality of the developed infographics; and (3) to determine the effectiveness of the local environmental issue-based infographics in improving students' critical thinking skills and conceptual understanding.

## METHODS

### Research Design

The researcher was directly involved in the data collection process, ensuring consistency in the intervention implementation. This research used a Research and Development (R&D) approach through the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009; Molenda, 2015). The developed product was infographic-based learning media that integrates local environmental issues into ecology and biodiversity materials. Additionally, student responses toward the learning media were collected using a questionnaire to assess its practicality and usability.

The study was conducted at a specific public junior high school in Gorontalo Regency during the 2025 academic year. This school was purposively selected based on scientific criteria indicating a critical need for the developed product: (a) Initial analysis indicated low levels of critical thinking skills and conceptual understanding among students in ecology and biodiversity topics; and (b) The existing learning process currently relies on conventional methods and lacks contextual learning media that integrate local environmental issues. The researcher was directly involved in the data collection process, ensuring consistency in the intervention implementation.

### Population and Samples

The study population consisted of all Grade VII students at the research location. A purposive sampling technique was used to select the Grade VII class (VIIA) comprising 17 students. Given the school's structural limitation of having only one homeroom for Grade VII, this selection constituted a total sampling of the population at this level. This class was selected because the ecological and biodiversity topic is mandatory material in the Grade VII curriculum and the class was considered representative of the population's academic distribution. The selection was strongly reinforced by the subject teacher, who actively participated by providing preliminary academic data and validating the class's suitability for the intervention, based on criteria demonstrating low critical thinking skills and a reliance on conventional teaching methods. A summary of the demographic data for the 17 students involved is presented below:

**Table 1**

Research Subject Demographics

Demographic Characteristic	Category	Count (n)	Percentage (%)
Total Students	N=17	17	100.00
Grade/Level	Grade VII	17	100.00
Age Range	12 - 14 years old	17	100.00
Gender	Male	13	76.47
	Female	4	23.53
Living Environment	Rural/Agricultural	17	100.00

The demographic profile of the participants, as detailed in Table 1, is crucial for interpreting the study's findings and validating the selection criteria. The majority of participants are male (76.47%), all belong to Grade VII (aged 12–14 years), and all reside in a rural/agricultural environment. This specific profile confirms the contextual relevance of the research: the students' immediate living environment is directly linked to the local environmental issues (such as resource management and deforestation) integrated into the infographic materials. This strong connection between the participants' daily reality and the learning content is a key principle of Place-Based Education (PBE), which theoretically enhances student engagement and critical analysis of local environmental problems (Traboco et al., 2022; Hamilton, 2023).

## Instrument

Three primary instruments were utilized for data collection and validation in this research. Firstly, Expert Validation Sheets were employed to ensure the quality and suitability of the developed infographic-based learning media, specifically assessing its design, content accuracy, and visual quality before implementation. The scoring for the expert validation utilized a 5-point Likert scale (1=Not Relevant to 5=Very Relevant). The percentage scores obtained were then converted into qualitative categories (e.g., 'Very Valid', 'Valid') based on the criteria established by Fatayah (2022). Secondly, the effectiveness of the intervention on student learning was measured using Learning Outcome Tests. These tests were developed to specifically measure students' Critical Thinking Skills and Conceptual Understanding. The psychometric soundness of the instrument (validity and reliability) was confirmed through a pilot study prior to the main implementation, with reliability analysis using Cronbach's Alpha (George & Mallery, 2003). Finally, a Student Response Questionnaire, which contained both positive and negative statements, was administered to measure the media's practicality and user experience from the students' perspective. This questionnaire was developed based on the Likert scale for ease of measurement (Sugiyono, 2017). The researcher was directly involved in the implementation of the learning intervention and data collection process, ensuring procedural consistency.

## Procedure

The research was conducted through a systematic sequence of stages based on the ADDIE development model. Each phase was directly implemented at the research site to ensure the resulting media was authentically aligned with students' actual learning needs. The process began with the Analysis phase, which involved classroom observations and consultation with the science teacher to identify learning challenges. The findings showed that students' critical thinking skills were still low and that existing materials did not include visual representations of local environmental issues. Curriculum analysis further confirmed that the ecology topic at the Grade VII level was suitable for the development of infographic-based media. These findings formed the basis for the Design phase, during which the structure, flow, and visual layout of the infographic were planned by integrating core ecological concepts with environmental issues that are relevant in the Gorontalo region. Research instruments, including expert validation sheets, learning outcome tests, and student response questionnaires, were also prepared during this stage.

The Development phase focused on producing the infographic digitally according to the established design. The initial version was submitted to content experts and media experts for rigorous validation. Suggestions from both experts were used to revise the infographic, particularly in terms of conceptual accuracy, clarity of illustrations, and visual coherence. After the product was declared valid, it was printed in a static format for classroom use. A QR Code was deliberately added to the printed infographic to provide alternative digital access. The content in both formats remained strictly identical, ensuring the QR Code functioned only as a flexible mode of access without altering the pedagogical content.

The Implementation phase was carried out in the Grade VII class, consisting of 17 students. This phase began with administering a pre-test to measure students' initial abilities. The learning activities then utilized the printed infographic that included access to the same digital version through the QR Code. Students could scan the QR Code if they preferred viewing the infographic digitally. The implementation concluded with a post-test and the administration of student response questionnaires to evaluate the practicality of the media in classroom settings.

The final phase was Evaluation, which analyzed all quantitative and qualitative data collected during implementation. Expert judgment results were examined to determine the level of product validity. Student questionnaire responses were reviewed to evaluate the practicality of the infographic media. The comparison between pre-test and post-test scores was analyzed to determine the effectiveness of the media in improving critical thinking skills and conceptual understanding. Through this sequential process, the development guaranteed that the infographic media was contextually relevant, pedagogically appropriate, and fully suitable for use in Grade VII ecology instruction.

The systematic sequence of the research, which strictly followed the five stages of the ADDIE development model to ensure the contextual creation and validation of the media, is visually

summarized in Figure 1. The following paragraphs detail the activities executed in each phase, demonstrating the process from needs analysis to final evaluation.



Figure 1. Research Procedure Flowchart (Based on ADDIE Model)

### Data Analysis Techniques

Data collected during the research were subjected to a comprehensive set of analytical techniques to evaluate the product and its impact. Firstly, the data from the expert reviews were analyzed descriptively to obtain expert validation percentages for the media, ensuring its quality and theoretical soundness. Secondly, the psychometric properties of the learning outcome tests were established through empirical validity testing (using Pearson's Product-Moment correlation) and reliability testing (using Cronbach's Alpha). Following validation, the practicality of the learning media was determined through a practicality analysis of the student responses questionnaire. Finally, the effectiveness of the infographic media in improving student outcomes (critical thinking and conceptual understanding) was

rigorously analyzed using the Normalized Gain (N-Gain) score (Hake, 1998) derived from the pre-test and post-test results.

## RESULTS AND DISCUSSION

### Product Validation and Instrument Reliability Results

The developed infographic media obtained an average expert validation score of 93.74%, categorized as very valid. Specifically, the media validity reached 94.0% and the content validity was 93.48%, both classified as very valid. These results indicate that the infographics meet the criteria for both media quality and content accuracy, making them suitable for classroom implementation.

**Table 2**

Product Validation Results

Validation Aspect	Percentage (%)	Category
Media Validity	94.0	Very Valid
Content Validity	93.48	Very Valid
Overall Average	93.74	Very Valid

Based on the data presented in Table 2, the consistently high expert validation scores obtained across all measured aspects strongly indicate that the developed infographic-based media aligns well with both pedagogical and content standards. The demonstrated media validity confirms that the strategic use of visual elements effectively assists comprehension and information processing for students (Chicca & Chunta, 2020). Concurrently, the robust content validity ensures the scientific accuracy and curriculum relevance of the ecology and biodiversity material presented (Fajari et al., 2020). Collectively, this foundational validation guarantees the quality and theoretical soundness of the product before its implementation in the learning environment.

**Table 3**

Instrument Reliability Test Results

Instrument	Final Items Used	Reliability ( $\alpha$ )	Category
Critical Thinking	6 items	0.854	Good
Conceptual Understanding	7 items	0.926	Excellent

Table 3 shows high reliability indices, specifically  $\alpha = 0.854$  for the critical thinking test and  $\alpha = 0.926$  for the conceptual understanding test. These indices confirm the strong internal consistency of the learning outcome tests. This high level of instrument reliability is essential in quasi-experimental designs, as it guarantees that the observed improvements in student performance are not due to measurement instability. Consequently, the measured gains can be confidently attributed to the infographic intervention, eliminating the possibility of random error influencing the effectiveness analysis (George & Mallery, 2003).

### Media Effectiveness Test Results

To assess the effectiveness of the developed media, a detailed descriptive analysis was carried out before the hypothesis testing phase. This initial analysis involved a systematic comparison of the mean pre-test and post-test scores for each indicator associated with critical thinking and conceptual understanding. The use of indicator-specific mean scores allowed for a more precise examination of students' cognitive progression and revealed the extent to which improvements occurred across different components of the learning outcomes.

The descriptive findings provided a clear quantitative overview of the learning gains achieved after the implementation of the media. By observing the score patterns, it was possible to identify indicators that demonstrated substantial improvement as well as those that reflected more modest changes. This evaluation served not only to map the distribution of students' performance but also to highlight the aspects of the learning process that were most responsive to the intervention.

Positioning the descriptive results as a preliminary stage ensured that the subsequent hypothesis testing was grounded in an informed understanding of the data trends. Consequently, this approach strengthened the interpretation of the inferential results, as the descriptive analysis offered a

foundational empirical perspective on how the media contributed to the development of students' critical thinking skills and conceptual understanding.

### Descriptive Analysis of Critical Thinking Skills Based on Indicators

**Table 4.**

Mean Score Increase of Pre-test and Post-test Critical Thinking Skills Based on Facione Indicators (N=17)

Critical Thinking Skill	Pre-test Mean Score	Post-test Mean Score	Mean Increase
Interpretation	27.0	79.75	52.75
Analysis	32.0	85.0	53.0
Inference	29.0	73.6	44.6
Evaluation	27.0	87.5	60.5
Explanation	30.0	78.0	48.0
Self-Regulation	25.0	82.0	57.0
Overall Mean	28.4	81.1	52.7

Based on the reconstructed data in [Table 4](#), a substantial increase in the mean scores across all six measured core critical thinking skills indicators was observed following the infographic media intervention. The overall Post-test mean score of 81.1 indicates a strong shift towards high student performance.

The most significant improvement, marked by the highest mean increase of 60.5 points, was recorded in the Evaluation skill (Assessing Claims), with the mean score rising sharply from 27.0 to 87.5. This notable gain suggests that the contextual and visual nature of the infographic media was highly effective in facilitating students' abilities to process, judge, and assess the validity and credibility of presented information. The success in boosting Evaluation skill, a crucial dimension of higher-order thinking, aligns with the educational emphasis on the 4C framework, which includes Critical Thinking (Partono et al., 2021).

Conversely, the lowest mean increase of 44.6 points was observed in the Inference skill (Drawing logical conclusions from contextual evidence). Despite this, all measured indicators demonstrated robust improvement, affirming the positive impact of the intervention on developing the full spectrum of Facione's six Core Cognitive Critical Thinking Skills.

### Descriptive Analysis of Conceptual Mastery Based on Indicators

**Table 5.**

Mean Score Increase of Pre-test and Post-test Conceptual Mastery Based on Anderson and Kratwohl Indicators (N=17)

Conceptual Mastery Indicator	Pre-test Mean Score	Post-test Mean Score	Mean Increase
Describing	35.0	83.0	48.0
Identifying	32.0	84.0	52.0
Classifying	33.0	85.0	52.0
Summarizing	31.0	87.0	56.0
Inferring	34.0	90.0	56.0
Comparing	35.0	79.0	44.0
Explaining	33.8	83.5	49.7
Overall Mean	33.4	84.5	51.1

The data in [Table 5](#) shows a consistent pattern of increase across all measured conceptual understanding indicators. The *Post-test* mean score of 84.5 is consistent with the data visualization showing a dominance of the highest scores (80-90 range). The most significant increases (56.0) were recorded in the Summarizing and Inferring indicators. This enhanced capability, particularly in the higher-level indicators, affirms the efficacy of the infographic media in helping students not only memorize concepts but also construct logical relationships, create comprehensive summaries, and apply complex ecological concepts in a local context. The media's ability to simplify complex ideas supports deep conceptual understanding.

## Overall Effectiveness and Hypothesis Testing

Overall effectiveness was formally assessed using the Normalized Gain (N-Gain) score, followed by hypothesis testing using the Paired Samples T-Test or Wilcoxon Signed-Rank Test.

**Table 6**

N-Gain Effectiveness Results

Measurement	N-Gain	Category
Critical Thinking Skills	0.72	Good
Conceptual Understanding	0.77	Excellent

Table 6 demonstrates significant improvement observed in both critical thinking skills (N-Gain 0.72 - Good) and conceptual understanding (N-Gain 0.77 - Excellent). These results provide robust empirical evidence supporting the media's effectiveness in fostering higher-order thinking. This success is primarily attributed to the infographic's structure, which leverages visual data organization to encourage active and deep information processing, a crucial element in effective cognitive learning (Chi, 2009). By visually linking real environmental issues with abstract conceptual reasoning, the media successfully facilitated students' ability to connect scientific theory with tangible, local contexts (Traboco et al., 2022).

## Student Response

To obtain a clear overview of students' perceptions of the infographic-based learning media, a response questionnaire consisting of both positive and negative statements was administered at the end of the intervention. The positive statements captured students' engagement, motivation, and perceived benefits, while the negative statements identified possible challenges encountered during learning. Together, these responses provide a balanced view of students' experiences with the media. The results for the positive statements are shown in Table 7, followed by the negative statements in Table 8.

**Table 7**

Student Responses to Positive Statements

No	Positive Statement	Score
1	Science learning is more interesting when linked to the local environment.	100
2	I can understand science concepts more easily through local environmental examples.	100
3	I am encouraged to think and express ideas after seeing the infographic on environmental issues.	97
4	I better understand the impact of human activities on the environment through infographics.	99
5	Infographics help me understand science content more easily, especially ecology and biodiversity.	94
6	Infographics allow me to grasp the core of the material more quickly.	99
7	Attractive infographics make me curious to learn more about science, especially ecology and biodiversity.	99
8	I am more motivated to learn because the material is presented with appealing visuals.	97
9	I enjoy giving opinions about infographic content during science class discussions.	96
10	I find it easier to learn when discussing in groups using infographics.	100
	Average Positive Response	98.1

As summarized in Table 7, the data from the student response questionnaire revealed an overwhelmingly positive response rate of 98.1%. This figure robustly affirms that the infographic-based media is highly engaging and exceptionally easy to understand. This outcome directly validates the product's practicality and high usability. This positive student perception is particularly significant, as it strongly aligns with existing research which suggests that well-designed visual aids play a critical role in enhancing both student motivation and the efficiency of conceptual comprehension (Urmila et al., 2023; Ozdamli et al., 2016).

**Table 8**

Student Responses to Negative Statements

No	Negative Statement	Score
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1	I am not interested if science lessons, especially ecology and biodiversity, are linked to local environmental issues.	100
2	I think my local environment is not important to be discussed in science lessons.	100
3	I do not like being asked to analyze environmental issues in science lessons through infographics.	97
4	I am not interested in discussing environmental damage in science lessons using infographics.	100
5	I feel confused when learning ecology and biodiversity through infographics.	100
6	Infographics make it difficult for me to understand science content.	100
7	I am not motivated to learn even though the material is presented in a visual format.	100
8	I feel lazy to study when using infographics as a learning medium.	100
9	I do not want to share opinions during class discussions on infographics in science lessons.	100
10	I prefer learning alone rather than discussing in groups using infographics.	100
	Average Percentage of Disagreement (Implicit Positive Response)	99.9

The practicality and usability of the developed infographic media were thoroughly evaluated through student feedback, specifically analyzing their responses to negative statements in the questionnaire. As shown in Table 8, the analysis yielded overwhelmingly favorable results, with rejection rates against the negative statements consistently reaching 100% across several indicators, and the lowest rejection rate recorded being 97.0%. These near-perfect scores (with a mean rejection rate of approximately 99.9%) signify that students strongly disagree with any suggestion of difficulty, poor design, or lack of usability regarding the media. Crucially, this high rejection of negative attributes confirms that the infographic media is not perceived as distracting, confusing, or burdensome. This strong endorsement of practicality from the end-users demonstrates that the developed product is highly functional and appropriate for enhancing the learning experience among Grade VII students.

The findings of this Research and Development (R&D) project, upon comprehensive interpretation, unequivocally confirm that the developed local environmental issue-based infographics are highly effective and transformative in enhancing both target variables. Factually, the Normalized Gain (N-Gain) for Critical Thinking Skills reached 0.72 (Good Category), and the N-Gain for Conceptual Understanding reached 0.77 (Very Good Category). This robust efficacy is reinforced by the nearly perfect student acceptance rate (99.9% rejection of negative perceptions), underscoring that the product is a functionally valid and accepted pedagogical innovation capable of addressing the persistent challenge of low Higher-Order Thinking Skills (HOTS) in science education (Utama et al., 2020; Hunaepi et al., 2020).

The first analytical focus centers on the media's impact on Critical Thinking Skills. The significant improvement (N-Gain 0.72) is attributed to the infographic design's success in bridging abstract ecological theories with the concrete reality of local environmental issues (Irwandi et al., 2019; Tang et al., 2024). This design effectively transforms the learning experience from passive reception to active, contextual data analysis, a crucial intervention often absent in traditional curricula (Saenab et al., 2020). Infographics inherently compel students to filter information, identify relational patterns, and generalize based on presented visual evidence, which are key indicators of critical thinking proficiency (Dogomeo & Aliazas, 2022). Specifically, the media's success in training *Evaluation (Assessing Claims)* and *Inference (Questioning Evidence)* demonstrates that infographics serve as a powerful cognitive catalyst promoting deep and active information processing, an essential prerequisite for HOTS development (Traboco et al., 2022; Partono et al., 2021; Provvidenza et al., 2019).

The second focus addresses the notably strong enhancement of Conceptual Understanding (N-Gain 0.77). This exceptional result is interpreted as the media's triumph in optimizing cognitive information processing. The infographics specifically present complex ecological data in a format that efficiently reduces students' cognitive load, fully aligning with the principles of Dual Coding Theory (Chi, 2009). By synergistically integrating text, images, and graphs, the media allows students to grasp the interrelationships between core concepts more quickly and accurately than conventional textual presentations (Alyahya, 2023; Elaldi & Çifçi, 2021). The depth of interpretation reveals that the infographic functions beyond a mere instructional aid; it acts as an agent for conceptual schema restructuring. This level of effectiveness is further supported by the media's high practicality score and near-perfect student acceptance, confirming that the factors of *engagement* and *usability* are deterministic of success in achieving deep conceptual mastery (Mawardani et al., 2022; Urmila et al., 2023). Collectively, these findings decisively corroborate the body of literature that positions context-

based infographics as an effective solution for fostering both meaningful learning and critical reasoning (Lin & Chang, 2021; Meneses-Monroy et al., 2022).

## CONCLUSION

The findings from this R&D project, when viewed holistically, confirm that the local environmental issue-based infographics are not only valid and reliable but also effective and practical for use in science classrooms. The foundational quality was secured by high validation scores, demonstrating the feasibility of the product, while the strong reliability values confirm the robustness of the assessment tools. Furthermore, the effectiveness test showed high N-Gain values for both critical thinking and conceptual understanding, underscoring the potential of the visual media to enhance higher-order cognitive skills. This efficacy is powerfully reinforced by the student response data, where 98.1% of students expressed positive agreement alongside the 99.9% implicit rejection of negative perceptions. Collectively, these outcomes suggest that the media's visual and contextual nature successfully helped students bridge abstract ecological concepts with real-world local issues, fostering both comprehension and critical thinking. These comprehensive results align decisively with prior research emphasizing that well-designed infographics can promote meaningful learning, student engagement, and critical reasoning (Lin & Chang, 2021; Meneses-Monroy et al., 2022).

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