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BETWEEN WORDS AND DATA: EXPLORING THE COORDINATION OF STUDENTS' VERBAL AND NUMERICAL LITERACY IN COMPREHENDING INFOGRAPHIC-BASED NEWS TEXTS

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ABSTRACT

News infographics combine verbal claims, numbers, graphs, icons, and visual hierarchy within a single text, meaning that reading comprehension requires more than sentence decoding. This conceptual development study explores how students coordinate verbal and numerical literacy when interpreting Indonesian-language news texts presented through infographics. A design-oriented synthesis was conducted across five domains: multimodal literacy in Indonesian language learning, infographic reading comprehension, mathematical and numerical literacy, text–graph integration, and critical reasoning. The synthesis generated the Verbal–Numerical Coordination in Infographics (VNC-I) framework, which conceptualizes comprehension as an iterative process of identifying verbal claims, decoding quantities and units, mapping verbal statements onto visual-numerical evidence, testing consistency, and formulating critical interpretations. The framework is operationalized through the READ-DATA cycle: Read the main claim, Examine the visual structure, Attend to numbers and units, Determine verbal–data relationships, Detect consistency, Advance an inference, Test credibility, and Articulate meaning. The article also proposes potential coordination breakdowns, including verbal dominance, percentage–percentage-point confusion, denominator blindness, scale neglect, and overclaiming beyond the data. The framework retains Indonesian language learning as the primary disciplinary domain while positioning mathematics as evidential reasoning embedded in authentic texts. Because the article does not report classroom data, the proposed dimensions require empirical validation through think-aloud protocols, student work, interviews, and task-based assessment in secondary-school Indonesian language classrooms.

Keywords: *multimodal literacy, numerical literacy, infographic news, verbal–numerical coordination, Indonesian language*

INTRODUCTION

The changing information ecology means that reading is no longer confined to linear paragraphs. Digital news is increasingly presented through combinations of headlines, brief paragraphs, numbers, percentages, graphs, icons, color, and visual layout. From a multimodal perspective, meaning is constructed through the orchestration of modes, each of which offers different representational resources (Kress, 2010; Kress & van Leeuwen, 2021). In Indonesian language learning, texts of this kind position students as both readers and viewers who must construct meaning from more than one mode of representation. Nur, Nurhadi, and Pratiwi (2023) show that multimodal texts have become an important component of Indonesian language textbooks under the Kurikulum Merdeka (Independent Curriculum); the forms identified include texts containing charts and infographics, with visual data used to strengthen arguments and support both reading and writing activities.

This need becomes even more important because understanding an infographic involves more than simply looking at an image. Infographics require readers to recognize verbal claims; read labels, units, scales, percentages, ratios, and trends; and then connect each element to the news message. OECD (2023a) defines mathematical literacy as the capacity to reason mathematically and to formulate, employ, and interpret mathematics in real-world contexts, including extracting information from tables and graphs and judging the reasonableness of a conclusion. At the same time, reading literacy requires readers to understand, use, evaluate,

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reflect on, and engage with texts, including digital texts that require the integration of multiple sources (OECD, 2019). Infographic-based news texts therefore lie directly at the intersection of language literacy and numerical literacy.

The intersection of these two domains is relevant to the Indonesian context. PISA 2022 records show that only about 25% of Indonesian students reached at least Level 2 in reading and about 18% reached at least Level 2 in mathematics (OECD, 2023c). These data cannot directly explain difficulties specific to infographics, but they indicate that both reading ability and mathematical reasoning require strengthening. Furthermore, OECD (2024) reports that reading fluency is associated with confidence in extracting mathematical information from diagrams, graphs, and simulations. These findings show that verbal and numerical challenges should not be rigidly separated.

Research on infographics has established an important foundation. Cahyani, Myartawan, and Hadi Saputra (2021) found improved reading comprehension in Indonesian EFL learning that used infographics in an online jigsaw setting. Carcamo and Pino (2025) likewise show that infographic-based instruction can improve multimodal reading comprehension and emphasize the importance of questions that distinguish verbal information, visual information, and the relationship between them. In Indonesian language learning, Hindriyani, Sudiana, and Wisudariani (2025) developed multimodal text media for Grade 7 news-text comprehension in narrative, infographic, and informative-video formats. This body of research reinforces the pedagogical value of infographics, but it does not yet fully explain how students coordinate linguistic claims with quantitative evidence when the two must be read simultaneously.

From the perspective of mathematics education, the work of Sonny Yalti Duma' and colleagues provides a relevant basis for positioning mathematics as a reasoning practice connected to context and representation. Duma, Muslimin, Modjo, and Walid (2024) emphasize the role of mathematics education in developing critical thinking and problem-solving. Ichsan, Mulyati, Duma, and Nirfayanti (2024) show that an interdisciplinary STEAM approach is relevant to the development of higher-order thinking skills. Regarding representation, Delastri, Lebang, Langi', and Duma (2024) describe visual reasoning as a process of investigation, interpretation, and application as students connect visual forms with mathematical concepts. Duma', Tandiseru, and Bali (2023) also demonstrate that mathematical elements can be explored through cultural objects that are close to students' lives. Taken together, these works support the idea that mathematics can function as a tool for reading, interpreting, and evaluating information, rather than merely as a collection of computational procedures.

However, a conceptual gap remains. Indonesian language studies of multimodal texts tend to emphasize form, media, and text comprehension; numeracy studies tend to place problems within mathematical contexts; and infographic research often measures gains in comprehension without mapping in detail the coordination points between language and data. In news texts, the issue emerges precisely in the relationship across modes: the word ‘meningkat’ (‘increased’) must correspond to the direction of the graph, the claim ‘naik 44%’ (‘increased by 44%’) must be linked to the correct comparison base, and broad conclusions must be tested against the scope of the data. This study therefore places verbal–numerical coordination at the center of its analysis.

This article aims to: (1) formulate the dimensions of verbal and numerical literacy coordination required to comprehend infographic-based news texts; (2) identify forms of conceptual breakdown that may occur when students read claims, numbers, and visuals; and (3) construct a learning and analytical framework that remains grounded in Indonesian language learning, with numeracy positioned as a tool for evaluating evidence within the text. The novelty of the article lies in shifting the focus from ‘reading text’ and ‘reading data’ as two

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separate activities toward an integrative process of meaning-making and critical evaluation of multimodal news. Three guiding questions are proposed: (1) What dimensions constitute the coordination of verbal and numerical literacy when students read infographic-based news? (2) What forms of conceptual breakdown should be anticipated? and (3) How can this coordination be operationalized as an Indonesian language learning cycle that can be empirically validated?

METHOD

This study employs a design-oriented conceptual development approach. The approach was selected because the purpose of the article is not to test a classroom intervention or report student data, but to synthesize theoretical foundations and research findings in order to produce a framework that can serve as the basis for empirical studies. The methodological structure follows the logic of the conceptual development article used as a template: sources are selected purposively, findings are coded into design requirements, and those requirements are then translated into operational constructs that can be tested in a subsequent stage.

Source Selection and Analytical Scope

Sources were purposively selected from literature representing five domains: (1) multimodal literacy and Indonesian language learning; (2) comprehension of infographics and visual texts; (3) mathematical/numerical literacy and data interpretation; (4) text–graph integration or multiple representations; and (5) critical reasoning and relevant mathematics education studies, including works by Sonny Yalti Duma'. Priority was given to scholarly articles and conceptual documents published from 2020 to 2026, while several earlier sources were retained when they provided relevant foundations. International policy and assessment sources were used to define reading and mathematical literacy, whereas Indonesian studies were used to maintain contextual relevance to Indonesian language learning.

Design Synthesis Procedure

The synthesis was conducted in three stages. First, each source was read to identify the cognitive actions required to comprehend multimodal texts, such as identifying claims, reading graphs, recognizing units, linking labels to sentences, comparing quantities, and evaluating evidence. Second, these actions were grouped into verbal–numerical coordination requirements. Third, each requirement was translated into indicators that could be observed in written responses, oral explanations, or think-aloud protocols. This process produced the VNC-I (Verbal–Numerical Coordination in Infographics) framework and the READ-DATA reading cycle as a pedagogical tool.

Conceptual Evaluation and Ethical Position

The framework was conceptually evaluated according to five criteria: coherence between the Indonesian language and numeracy domains, traceability of each indicator to the literature, applicability to authentic news texts, classroom assessability, and sensitivity to media-literacy ethics. This article did not collect data from human participants and makes no causal claims about improved learning outcomes. The included infographic examples use simulated data so that the conceptual framework is not conflated with factual claims about a particular school or population.

RESULTS

Contextual Design Requirements

The synthesis generated five main design requirements. First, readers must be able to extract verbal propositions: who or what is being discussed, what change is claimed, over what

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time span, and with what degree of certainty. Second, readers need to decode relevant numerical information, including units, denominators, scales, percentages, ratios, and absolute differences. Third, readers must map relationships across modes so that a phrase in a news text can be linked to the correct graph bar, label, number, icon, or source note. Fourth, readers make quantitative inferences that are proportional to the data. Fifth, readers evaluate whether the headline or conclusion is genuinely supported by the data and whether information is missing, scales are misleading, or generalizations are excessive.

Table 1. Dimensions of verbal–numerical coordination in infographic-based news texts

Dimension	Indonesian Language Focus	Mathematical/Numerical Element	Expected Evidence
Claim extraction	Main idea, evaluative words, causal relationships, temporality	Identify the quantity referred to by the claim	Students can restate the claim precisely
Quantitative decoding	Understand labels and captions	Numbers, units, percentages, ratios, trends, scales	Students can explain what each number means
Cross-modal mapping	Cohesion among sentences, headlines, legends, and visuals	Match data with representations	Students can point to the visual evidence supporting a particular sentence
Proportional inference	Interpret the meaning of change	Difference, relative change, percentage points, comparison	Students calculate/reason about change using the correct basis
Critical evaluation	Evaluate credibility and strength of argument	Check reasonableness, scale, denominator, and data scope	Students accept, revise, or reject a claim with reasons

The VNC-I Conceptual Framework

The VNC-I framework views comprehension of infographic-based news as the construction of an integrated mental model. Verbal, numerical, and visual information is not read sequentially and in isolation; readers move back and forth among modes to test correspondence. Figure 1 positions three representational layers as information sources that must be consolidated before readers construct an interpretation and a critical evaluation. This framework is consistent with multimedia learning perspectives in which combinations of representations are beneficial only when readers construct relevant connections among their elements (Mayer, 2021; Richter et al., 2021).

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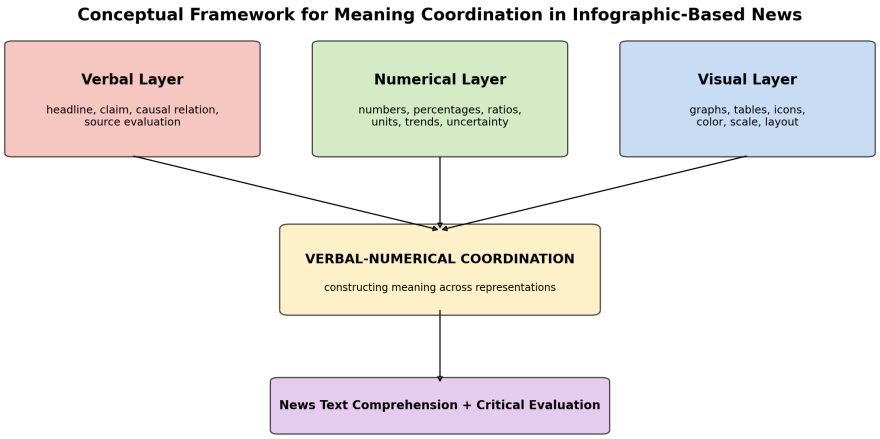
Figure 1. Conceptual framework of verbal–numerical coordination in infographic-based news

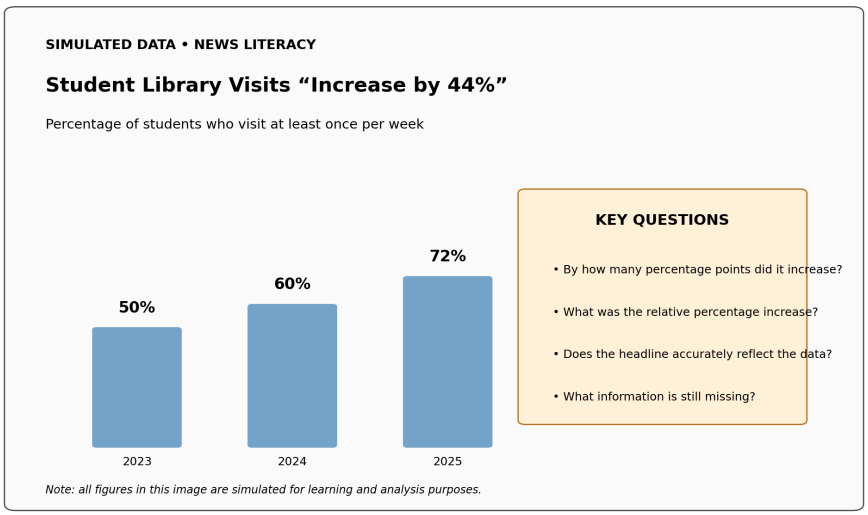


Within this framework, verbal literacy remains the anchor. Students must first understand the function of news: to communicate factual information, identify who or what is being reported, and distinguish data statements from interpretation. Mathematical elements then function as evidence that must be interpreted. This positioning is important so that the study does not become a mathematics test merely wrapped in an Indonesian-language text. Instead, computation is used only to the extent required to answer broader linguistic questions: Is the claim accurate? Does the diction exaggerate the data? Is the conclusion consistent with the evidence presented?

Illustrative Infographic Reading Task

Figure 2 presents an example using simulated data. The headline states that student library visits 'increased by 44%,' while the graph shows a change from 50% in 2023 to 72% in 2025. In absolute terms, the change is 22 percentage points. Relative to the initial value, the increase is 44%. Both statements can be correct, but they convey different meanings. The reader's task is to determine which measure is used in the headline, explain the comparison base, and judge whether the headline provides sufficient context.

Figure 2. Example of a simulated news infographic for a verbal–numerical coordination task



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The example illustrates why Indonesian language competence and mathematical competence are mutually necessary. The word 'increase' establishes a comparative relation, but the magnitude of the increase cannot be understood without numerical operations. Conversely, calculating 44% does not by itself resolve the quality of the news report; readers must still assess whether the headline, caption, source, and scope of the data are communicated adequately. At this point, numeracy functions as an instrument of critical reading.

Table 2. Example analytical questions for the simulated infographic

Level of Analysis	Question	Coordination Focus
Verbal	What is the main claim stated in the headline?	Identify the proposition and evaluative diction
Numerical	What is the difference between 50% and 72% in percentage points?	Distinguish the initial value, final value, and difference
Relational	Why can 22 percentage points be equivalent to a 44% relative increase?	Explain the comparison base
Critical	Is the headline 'increased by 44%' sufficiently clear for readers?	Evaluate data-based linguistic precision
Production	Rewrite the headline to make it more informative without changing the data.	Articulate meaning across modes

Potential Coordination Breakdowns

The framework also generates a typology of breakdowns, or points at which coordination may fail. This typology is conceptual and does not yet constitute an empirical finding. Its purpose is to provide initial categories for future qualitative research analyzing students' responses and explanations.

Table 3. Conceptual typology of verbal–numerical breakdowns

Breakdown	Response Characteristics	Comprehension Risk
Verbal dominance	Student merely repeats the headline/paragraph and ignores the graph	The claim is accepted without verifying the evidence
Numerical decoding error	Misreads units, percentages, scales, or legends	The meaning of the data is altered from the initial stage
Percentage-point confusion	Treats a percentage increase as identical to a percentage-point increase	The magnitude of change is overstated or understated
Denominator blindness	Uses percentages without considering the base/population	Comparisons across groups become invalid
Cross-modal mismatch	Links a sentence to the wrong visual element	Text–graph cohesion is broken
Scale neglect	Does not attend to the axis starting point or intervals	The visual trend is overinterpreted
Overclaim	Draws a conclusion broader than the available data	The news is treated as proving unsupported causation or generalization

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The READ-DATA Reading Cycle

To make the framework applicable to instruction, the synthesis was translated into the READ-DATA cycle. The cycle is not a rigid algorithm, but a sequence of questions that helps students move from text comprehension to evidence evaluation: Read the main claim; Examine the visual structure; Attend to numbers and units; Determine verbal–data relationships; Detect consistency; Advance an inference; Test credibility; and Articulate meaning. The sequence can be repeated whenever students identify an inconsistency between a claim and the data.

Figure 3. The READ-DATA cycle for critical reading of infographic-based news

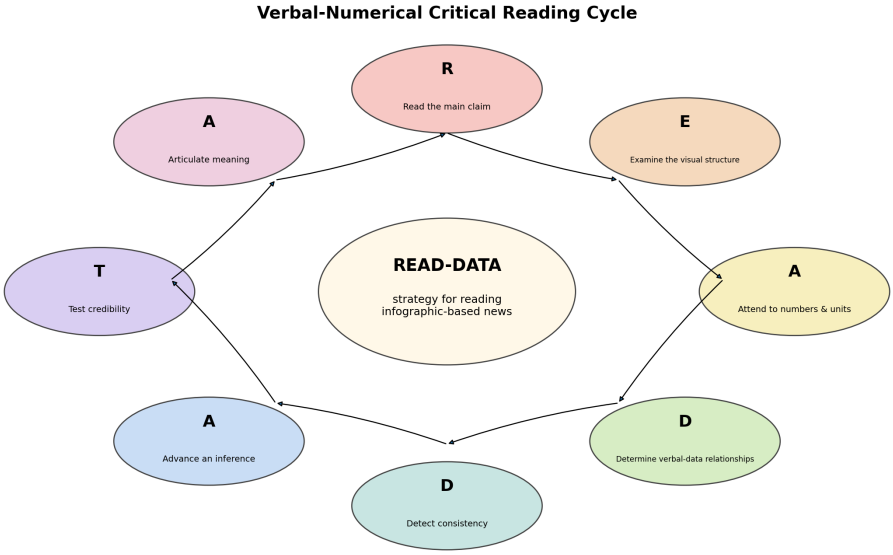

Table 4. Operationalization of the READ-DATA cycle in Indonesian language learning

Stage	Student Action	Teacher Question	Evidence of Learning
R – Read the main claim	Mark the headline, lead, and key statements	What is actually being claimed?	Paraphrase of the claim
E – Examine the visual structure	Identify graphs, icons, legends, and sources	Which visual component carries the evidence?	Map of infographic elements
A – Attend to numbers & units	Read numbers, percentages, ratios, and scales	What does this number represent, and what is its unit?	Numerical explanation
D – Determine relationships	Match sentences with visual evidence	Which data support this sentence?	Text–data correspondence
D – Detect consistency	Check differences, trends, scales, and denominators	Is the claim accurate or too strong?	Verification notes
A – Advance an inference	Draw a reasonable conclusion	What can and cannot yet be concluded?	Inference constrained by the data
T – Test credibility	Check source, period, and scope	Where do the data come from, and who is represented?	Source evaluation
A – Articulate meaning	Rewrite the headline/conclusion	How can the data be stated in the most precise language?	Revised news text

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Assessment Indicators and Future Validation

Appropriate assessment needs to capture the coordination process, not only the final answer. Students can be asked to annotate an infographic, identify the number that supports a claim, explain their reasoning orally, or rewrite a headline. Duma (2017) shows that mathematics learning outcomes may be influenced by instructional models, cognitive styles, and prior ability; therefore, empirical validation of this framework should also consider prior knowledge and reader characteristics so that coordination difficulties are not interpreted solely as weaknesses in numeracy.

Table 5. Formative rubric for verbal–numerical coordination

Indicator	Emerging	Developing	Achieved
Verbal comprehension	Copies the text without explaining the claim	Identifies the claim but lacks precision	Paraphrases the claim together with its limitations
Numerical interpretation	Misreads numbers/units	Reads numbers correctly but the relationship remains unclear	Accurately interprets numbers, units, scales, and comparisons
Cross-modal integration	Treats text and visuals separately	Recognizes some relationships	Explicitly links claims to visual-numerical evidence
Critical evaluation	Accepts the headline without examination	Detects a problem but the reasoning is incomplete	Evaluates the claim, source, and data limitations with reasons

DISCUSSION

The VNC-I framework emphasizes that the mathematical component of this study is not positioned as a second subject standing alongside Indonesian language learning. The primary domain remains the reading and viewing of news texts: students identify ideas, word choices, relationships across sentences, information structure, source credibility, and the strength of claims. Numerical elements enter as part of the text content that must be understood to ensure that verbal meaning is constructed responsibly. This positioning keeps the study predominantly within Indonesian language education while retaining a substantive mathematical component.

The synthesis is consistent with findings on multimodal learning. Carcamo and Pino (2025) show that infographics can support reading comprehension, but successful reading requires attention to text-based questions, image-based questions, and questions that integrate the two. Richter et al. (2021) likewise emphasize that learning from text–graph combinations requires cross-representational connections; supports such as signaling may be particularly helpful when prior knowledge is low. Thus, the benefit of visual representation is not an automatic property of infographics. An image or graph becomes a learning resource only when readers understand its representational function and connect it to the text.

Indonesian Language as the Primary Disciplinary Home

A major strength of this design is its connection to reading and viewing competencies. Nur et al. (2023) found that Indonesian language textbooks under the Kurikulum Merdeka contain diverse forms of multimodal texts, including infographics and charts, and use them to help students construct meaning. Hindriyani et al. (2025) more specifically developed multimodal media for Grade 7 reading comprehension of news texts. VNC-I extends this direction by adding one analytical layer: when a news text includes data, readers need to evaluate whether its linguistic choices are coherent with the quantitative evidence.

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This is important because words in news texts can create quantitative impressions. Terms such as ‘melonjak’ (‘surged’), ‘merosot’ (‘declined’), ‘mayoritas’ (‘majority’), ‘hampir semua’ (‘almost all’), ‘dua kali lipat’ (‘doubled’), or ‘meningkat tajam’ (‘increased sharply’) make claims about magnitude. Their use cannot be evaluated through grammar alone; readers need a numerical referent. Here, mathematics functions as the quantitative semantics of language. Conversely, numbers without language are also insufficient because readers must know what is being measured, who the population is, when the measurement was taken, and what limits should be placed on the conclusion.

Critical Reasoning and the Contribution of Sonny Yalti Duma’s Work

The connection with Sonny Yalti Duma's work can be seen in three directions. First, Duma et al. (2024) position mathematics as a vehicle for developing critical thinking and problem-solving. In the context of this article, critical thinking is realized by examining whether news claims are consistent with the data. Second, Ichsan et al. (2024), with Duma as a co-author, emphasize STEAM integration as an interdisciplinary experience that promotes analysis and the application of concepts in practical contexts. VNC-I applies a similar principle, but its interdisciplinary context is Indonesian language–numeracy integration. Third, Delastri et al. (2024) describe visual reasoning through stages of investigation, interpretation, and application; this pattern supports the idea that readers should not merely look at a graph, but investigate its form, interpret the relationships it represents, and use it to answer questions of meaning.

Duma' et al. (2023) on ethnomathematics also provide an important epistemological implication: mathematical elements can be found and interpreted through cultural contexts, not only through formal problems. In this article, that context is extended to news texts and infographics. Thus, when students read percentages in social news, graphs in environmental news, or ratios in economic news, they are engaging in mathematical activity embedded in everyday literacy practices. This perspective strengthens the rationale for integrating numerical elements into Indonesian language learning without shifting the disciplinary identity of the subject.

From Comprehension to Critical News Literacy

Verbal–numerical coordination also extends the goal from comprehension toward critical news literacy. Readers who can calculate change but do not evaluate the source remain vulnerable to misleading claims; likewise, readers who can identify the main idea but do not understand the basis of a percentage may accept a disproportionate narrative. For this reason, the ‘Test credibility’ stage in READ-DATA is deliberately positioned after the examination of data. Before drawing a conclusion, students need to inspect the source, time period, sample coverage, categories, and possible data that are not displayed.

The pedagogical implication is that Indonesian language teachers do not need to teach mathematics broadly. They need only select the numerical demands that are inherent in the text, such as reading percentages, differences, simple ratios, trends, scales, and comparisons. Collaboration with mathematics teachers can be used when a text requires more complex concepts. This approach is consistent with the spirit of interdisciplinary integration reported by Ichsan et al. (2024), while retaining language-learning objectives: understanding, evaluating, and producing texts supported by accurate evidence.

Research Implications and Limitations

The framework generates several research agendas. Qualitative studies can use think-aloud protocols to record shifts in students' attention among headlines, paragraphs, numbers, legends,

and graphs. Task-based interviews can trace why students accept or reject a claim. Analyses of student work can use the breakdown categories in Table 3 and then revise them inductively as new categories emerge. Subsequent quasi-experimental studies can test whether READ-DATA instruction improves news-text comprehension, the accuracy of data interpretation, and the quality of critical evaluation.

The main limitation of this article is its conceptual nature. The breakdown typology has not been tested with students and should not be treated as an already validated psychological classification. The infographic example uses simulated data and therefore serves only to demonstrate the logic of analysis. In addition, numerical literacy in news may involve concepts broader than those captured by the initial framework, such as uncertainty, probability, margin of error, and correlation. Empirical validation is needed to determine the appropriate level of complexity for different student levels and news genres.

CONCLUSION

This article proposes verbal–numerical literacy coordination as a perspective for understanding infographic-based news texts in Indonesian language learning. The VNC-I framework places five processes at the core of reading: claim extraction, quantitative decoding, cross-modal mapping, proportional inference, and critical evaluation. These processes are translated into the READ-DATA cycle so that teachers and students have an explicit sequence for reading news that combines words, numbers, graphs, and visual elements.

The framework's main contribution is that it keeps Indonesian language learning as the primary domain while using mathematics as an evidential tool. Students are not directed to ‘do mathematics’ as a separate activity, but to use numbers and data representations to understand linguistic choices, test the accuracy of claims, and rewrite information more precisely. This position is relevant to the demands of multimodal literacy and to the idea that mathematical reasoning supports critical thinking in real-world contexts (Duma et al., 2024).

The next stage is empirical validation with junior or senior secondary students through authentic news-reading tasks, think-aloud protocols, interviews, and analysis of written artifacts. Such research needs to examine whether patterns of verbal dominance, percentage-point confusion, denominator blindness, cross-modal mismatch, scale neglect, and overclaiming actually occur and how students repair them. Through staged validation, the framework has the potential to bridge Indonesian language education, numerical literacy, and critical media literacy.

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