



AR Module Development for Reading Comprehension: An Ethno-Meaningful Learning Needs Analysis

Atika Zikri

Universitas Negeri Padang,
Indonesia

*Afnita

Universitas Negeri Padang,
Indonesia

Syahrul Ramadhan

Universitas Negeri Padang,
Indonesia

Nursaid

Universitas Negeri Padang,
Indonesia

***Corresponding author:**

Afnita, Universitas Negeri Padang, Indonesia.

✉ afnita@fbs.unp.ac.id

Article Info:

Article history:

Received: May 15, 2026

Revised: July 07, 2026

Accepted: July 09, 2026

Keywords:

Augmented Reality; Ethno-Meaningful Learning; Minangkabau; Needs Analysis; Observation Report Text; Reading Comprehension

Abstract

Background: Indonesian students' reading comprehension proficiency remains a critical challenge, as evidenced by Indonesia's ranking of 71st among 81 participating countries and economies in PISA 2022, with a reading score of 359, substantially below the OECD average.

Objective: This study presents a needs analysis as the foundational phase in developing an interactive augmented reality (AR) module based on Ethno-Meaningful Learning to improve senior high school students' reading comprehension of observation report texts.

Methods: Using a descriptive qualitative approach, data were collected through questionnaires, interviews, and document analysis involving nine Indonesian language teachers and 34 students at SMA Pembangunan Padang.

Results: The results reveal significant gaps between current learning conditions and ideal learning requirements: (1) 88.9% of teachers still rely on conventional, text-based instruction; (2) 82.5% of students find reading lessons un motivating; (3) 94.1% of students have never experienced AR-based learning; and (4) 100% of teachers confirmed the absence of interactive digital modules integrating local Minangkabau culture. A gap analysis across five dimensions (methods, media, content, technology, and literacy) confirms the urgent need for an innovative, culturally grounded, and technology-enabled learning solution.

Conclusion: These findings substantiate the need to develop an interactive AR-based module that integrates Ethno-Meaningful Learning principles to enhance students' literal, inferential, and critical comprehension of observation report texts. This study contributes a culturally grounded and empirically validated framework for developing AR-based reading modules, thereby advancing the integration of ethnopedagogy and educational technology into Indonesian language instruction.

To cite this article: Zikri, A., Afnita, Ramadhan, S., & Nursaid. (2026). AR module development for reading comprehension: An ethno-meaningful learning needs analysis. *Glosains: Jurnal Sains Global Indonesia*, 7(3), 1176–1187. <https://doi.org/10.59784/glosains.v7i3.789>

INTRODUCTION

The development of 21st-century education positions literacy as a fundamental competency that cannot be overlooked. In an era characterized by the rapid flow of digital information, reading ability is no longer limited to recognizing and understanding written symbols; rather, it encompasses the critical capacity to select, evaluate, and utilize information meaningfully. UNESCO (2023) affirms that digital literacy, critical thinking skills, and technological innovation are essential competencies for the younger generation to adapt to the continuously evolving complexity of the global landscape. Within this framework, reading literacy plays a fundamental role as the foundation for understanding, processing, and critically evaluating

information from diverse sources.

Nevertheless, Indonesia's reading literacy achievement remains at an alarming level. The results of the Programme for International Student Assessment (PISA) 2022 reveal that Indonesia ranked 71st out of 81 countries, achieving a score of 359, which remains significantly below the OECD average of 476 (OECD, 2023). This figure is not merely a statistical indicator; it reflects the reality that many Indonesian students have yet to develop advanced textual comprehension skills, including the ability to draw inferences, interpret implicit meanings, and critically evaluate information. Furthermore, longitudinal studies indicate that this achievement has demonstrated limited progress over the past decade, suggesting the persistence of structural issues in literacy instruction at the school level (Tohir, 2019).

This condition confirms that students' ability to read and comprehend texts deeply remains insufficient and requires serious attention within the learning process. Furthermore, the 2023 National Computer-Based Assessment (ANBK) results reinforce this trend at the national level, showing that many Indonesian students have not yet reached proficient literacy levels, indicating that low reading comprehension remains a systemic challenge within the Indonesian education system (Kemendikbudristek, 2023).

In the context of Indonesian language learning, the observation report text (teks laporan hasil observasi/LHO) represents one genre that particularly requires critical and analytical reading abilities. The LHO is a factual-descriptive text that requires students to identify objective facts, understand the hierarchical structure of the text—including general definitions, partial descriptions, and conclusions—as well as recognize linguistic features and logical conjunctions that function as markers of textual cohesion (Hotimah, 2022).

This complexity presents a distinctive challenge, particularly for students who are unfamiliar with engaging with dense and formal informational texts. Laia (2023) found that students frequently misidentify the essential components of observation report texts due to the limited availability of examples and learning media that facilitate concept visualization. Dewi (2019) similarly revealed that many students continue to experience difficulties in understanding text structures and linguistic features, resulting in an incomplete interpretation of the overall meaning of the text.

The difficulties students encounter in comprehending observation report texts are influenced by several interrelated factors. First, the dominance of lecture-based methods and repetitive exercises in instruction often makes reading activities less meaningful; students are positioned as passive recipients of information rather than active readers who construct their own understanding. Second, existing learning media have not adequately accommodated students' visual and interactive needs in constructing comprehension of informational texts with complex structures (Harahap, 2025). Third, the texts used in instruction are frequently disconnected from students' cultural backgrounds and lived experiences, thereby reducing reading motivation and engagement. However, the Merdeka Curriculum Kemendikbudristek, (2023) explicitly emphasizes the importance of contextual learning that connects learning materials with students' social and cultural environments as a foundation for meaning-making.

Augmented Reality (AR) technology offers transformative potential for addressing these challenges. Unlike conventional learning media, AR enables the integration of digital elements including text, three-dimensional objects, animations, and audio into real-world environments in real time through mobile devices (Azuma, 1997). Akçayır (2017), in their systematic review, found that the use of AR in educational modules consistently improves learning outcomes, reduces misconceptions, and enhances information retention. In the context of reading instruction, AR-based modules provide multimodal support through visual, textual, and interactive representations that can facilitate comprehension, particularly for informational texts such as observation report texts.

Parmaxi (2020) further demonstrated that well-designed AR applications can significantly enhance motivation and learning engagement compared with conventional instructional media because students are not merely reading textual content but also interacting with it through immersive experiences. However, it is equally important to acknowledge the practical challenges associated with AR implementation in Indonesian schools, including unequal access to technological devices, limited teacher digital literacy, unstable internet connectivity in

rural areas, and the substantial costs associated with AR application development (Akçayır & Akçayır, 2017; Garzón et al., 2019). These constraints must be carefully considered during the module design phase to ensure equitable, accessible, and sustainable implementation.

Simultaneously, the Ethno-Meaningful Learning approach emerges as a relevant solution that integrates local cultural values into the learning process, making learning materials easier to understand while also rendering them more personally and socially meaningful. Sudarmin (2019) explain that this approach is grounded in the assumption that learning is most effective when content is connected to students' cultural experiences, thereby facilitating the construction of new meanings that remain inseparable from their cultural identities. In this context, integrating observation report texts with Minangkabau cultural objects such as the rumah gadang, tari piring, and the nagari governance system will not only increase students' reading interest but also help them understand text structures contextually through objects that are familiar in their everyday lives.

This ethnopedagogical approach is also aligned with the principles of differentiated learning advocated by the Merdeka Curriculum, wherein the diversity of students' cultural backgrounds is regarded as a strength rather than a variable to be neutralized. Concretely, the principles of Ethno-Meaningful Learning will be implemented in the AR module through three mechanisms: (1) using Minangkabau cultural objects as the primary thematic content of observation report texts; (2) embedding cultural context prompts and AR annotations that activate students' prior cultural knowledge; and (3) designing culturally responsive comprehension tasks that connect textual analysis with students' lived cultural experiences (Putri & Fitri, 2025; Sudarmin et al., 2019).

Although the potential of AR technology and ethnopedagogical approaches has received attention individually in the educational literature, research that integrates both within a unified framework—particularly in the development of reading modules for senior high school students—remains extremely limited. Previous studies have generally developed AR-based learning media without a strong cultural context, or conversely, have emphasized cultural dimensions without the support of interactive technology. This research gap constitutes a significant epistemological lacuna, given that the synergy between AR and ethnopedagogy has the potential to produce learning experiences that are not only cognitively effective but also culturally rich and socially meaningful.

Specifically, no previous study has simultaneously addressed three critical dimensions: (1) the technological dimension, developing AR-based interactive modules for Indonesian language reading instruction; (2) the pedagogical dimension, applying Ethno-Meaningful Learning as the foundational instructional approach; and (3) the cultural-contextual dimension, embedding Minangkabau local wisdom as the substantive content of reading texts at the senior high school level. This tripartite novelty distinguishes the present research and justifies its scientific contribution to educational technology and Indonesian language pedagogy.

Departing from this background, the present study is designed as the initial phase of a broader research and development (R&D) study employing the 4D model (Define, Design, Develop, Disseminate). This paper specifically focuses on the Define phase, namely the needs analysis stage, which serves as the empirical foundation for all subsequent stages of development. A systematic, field-based needs analysis is crucial to ensuring that the developed product is genuinely valid, practical, and effective in addressing actual learning challenges (Branch & Varank, 2009; Dick et al., 2001). Without a robust needs analysis as its empirical foundation, module development risks producing a product that is technically innovative yet irrelevant to students' authentic needs and learning contexts.

Accordingly, the objective of this study is to systematically identify and analyze the learning needs related to reading comprehension of observation report texts at SMA Pembangunan Padang as the empirical basis for developing an AR-based interactive module grounded in the Ethno-Meaningful Learning approach. The findings of this analysis are expected to contribute not only to the development of the intended module but also to the broader body of research in Indonesian language education that integrates advanced educational technology with local cultural wisdom.

METHOD

This study employed a descriptive qualitative approach to conduct a systematic needs analysis as the Define phase of a larger 4D Research and Development (R&D) study. The research aimed to describe and analyze the current conditions and needs of Indonesian language learning specifically reading comprehension of observation report texts—to establish the empirical foundation for developing an AR-based interactive module.

The study was conducted at SMA Pembangunan Padang, located at Jalan Nipah Nomor 1, Padang Barat, West Sumatra. This school was selected based on several criteria: (1) its implementation of Merdeka Curriculum, (2) adequate technological infrastructure including stable WiFi, computer laboratories, and a Bring Your Own Device (BYOD) policy, (3) the predominance of Minangkabau ethnicity among students, making the Ethno-Meaningful Learning approach highly contextual, and (4) strong principal and teacher support for research activities. It is acknowledged that the selection of a single school limits generalizability; however, this is consistent with the Define phase of the 4D model, where the primary objective is deep contextual understanding rather than broad statistical representation. The findings are explicitly intended as the empirical basis for subsequent design and development phases, with broader validation planned across multiple schools during the Disseminate phase (Branch & Varank, 2009; Thiagarajan, 1974).

Participants consisted of two groups: (1) 9 Indonesian language teachers selected through purposive sampling based on teaching experience (minimum 3 years) and familiarity with Merdeka Curriculum; and (2) 34 students from Class XI selected through random sampling from two classes, representing diverse academic abilities. The adequacy of this sample is supported by needs analysis methodology literature, which indicates that purposive samples of 5–15 expert informants and 30–40 student respondents are sufficient to achieve informational saturation in qualitative-dominant needs studies (Branch & Varank, 2009; Dick et al., 2001). The combination of teacher depth (9 experienced instructors) and student breadth (34 across ability levels) ensures both pedagogical expertise and learner perspective are comprehensively captured.

Data were collected through three main instruments. First, structured questionnaires with Likert scale items (1–5) were administered to both teachers and students. The teacher questionnaire examined: current teaching methods and media, student difficulties in reading LHO texts, media needs, cultural relevance perceptions, and readiness for technology integration. The student questionnaire explored: learning motivation, media preferences, technology access, reading difficulties, and cultural identity in learning.

Second, semi-structured interviews were conducted with 4 teachers and 8 students to obtain in-depth qualitative data on learning experiences and needs. Third, document analysis was performed on school curriculum documents, lesson plans (RPP/Modul Ajar), student assessment results, and national reading achievement data. To ensure instrument quality, content validity was established through expert review by two Indonesian language education specialists and one educational technology expert. Readability was tested through a pilot administration with five teachers and ten students not included in the main study. Internal consistency of the Likert-scale questionnaire items was confirmed through Cronbach's alpha analysis ($\alpha = 0.87$ for the teacher instrument; $\alpha = 0.84$ for the student instrument), both exceeding the acceptable threshold of 0.70. For interview guides, credibility was enhanced through member checking, where key findings were returned to selected participants for verification.

Table 1. Needs Analysis Research Instrument Framework

No.	Aspect Under Study	Indicator	Respondent
1	Current learning condition	Method, media, and the approach used by the teacher	Teachers & Students
2	Learning Media Needs	Types of media preferred by students and teachers	Teachers & Students
3	Local Cultural Content Needs	Relevance of Minangkabau culture in learning	Teachers & Students
4	Technology Proficiency	Students' ability and access to smartphone/computer	Siswa

5	Students' Reading Skills	Level of ability in reading observation report texts	Guru
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Quantitative data obtained from the questionnaires were analyzed using descriptive statistics, including frequency, percentage, and mean scores. Qualitative data derived from interviews and document analysis were examined through thematic analysis Braun (2006), following the stages of familiarization, coding, theme development, theme review, and report writing. A gap analysis framework was applied to systematically compare existing conditions with ideal learning requirements across five dimensions: instructional methods, media, content, technology, and literacy outcomes. Data source triangulation was employed to enhance the credibility and validity of the findings. The thematic coding process was conducted collaboratively by two researchers, involving initial independent coding followed by consensus discussions to resolve discrepancies. Inter coder agreement was evaluated using Cohen's Kappa coefficient ($\kappa = 0.82$), indicating substantial agreement and strengthening the credibility of the qualitative analysis (Braun & Clarke, 2006).

RESULTS AND DISCUSSION

Results

Current Conditions of Reading Learning (Teacher Perspective)

Analysis of teacher questionnaire responses revealed a consistently conventional learning landscape. The majority of Indonesian language teachers at SMA Pembangunan Padang reported reliance on traditional instructional approaches dominated by lecture, text-based exercises, and rote memorization.

Table 2. Teacher Questionnaire Results on Current Learning Conditions and Needs

No	Questions	Response (%)
1	The reading instruction method remains conventional (lectures and exercises)	88,9%
2	Students have difficulty understanding the structure of observation report texts	88,9%
3	No interactive digital media are currently available for reading LHO (<i>Laporan Hasil Observasi</i> , Observation Report Text)	100%
4	Teachers agreed that an AR technology-based module is needed	88,9%
5	Teachers agreed that the integration of Minangkabau culture is relevant to learning	100%

The findings presented in Table 2 reveal a critical pattern: 88.9% of teachers confirmed that current reading instruction remains conventional, relying predominantly on lectures and rote exercises without meaningful engagement strategies. This finding is consistent with Wijaya (2026), who identified conventional teacher-centered instruction as a primary barrier to reading comprehension development in Indonesian secondary education, and with Wahidmurni (2024), who documented that more than 80% of surveyed Indonesian high school teachers still rely on lecture-based methods despite curriculum reforms. All nine teachers (100%) confirmed the complete absence of interactive digital modules that integrate local Minangkabau culture into reading instruction. Teachers further reported that students' weakest competency lies at the inferential reading level, particularly in drawing conclusions, interpreting implicit information, and evaluating the logical coherence of observation reports.

Interview data further strengthened these quantitative findings. One teacher stated, "Students can read the words, but they cannot construct meaning, especially in observation report texts that use technical language. We do not have any media that visually presents the objects being described" (Teacher Interview, 2025). Another teacher highlighted the cultural disconnect: "When texts use examples from outside Minangkabau, students seem detached. They respond much better when the examples are taken from our own environment" (Teacher Interview, 2025).

Student Learning Experiences and Needs

Student questionnaire responses corroborated teacher observations and added the critical dimension of learner perspective.

Table 3. Student Questionnaire Results on Learning Experience and Technology Needs

No	Question	Agree (%)
1	Learning to read in the classroom is less interesting	82,5%
2	Difficulty understanding the structure and content of the text of the observation report	79,4%
3	Want to learn how to use smartphone-based interactive media	91,2%
4	Interested if the material is associated with Minangkabau culture	88,2%
5	Never learned to read using Augmented Reality	94,1%

Table 3 demonstrates that 82.5% of students perceived reading lessons as un motivating, which is consistent with the findings of Indrayadi (2021) regarding Indonesian students' low intrinsic reading motivation. Critically, 94.1% of students reported having never experienced AR-based learning, confirming the novelty of the proposed intervention. However, the possibility of response bias must be acknowledged: students who have never experienced augmented reality (AR) technology may express excessive enthusiasm due to the novelty effect rather than genuine pedagogical evaluation. To mitigate this limitation, interview data were triangulated with questionnaire responses to cross-validate student preferences, and the research design incorporates empirical validation through expert reviews and field trials in subsequent 4D development phases (Garzón et al., 2019). A strong majority (91.2%) expressed enthusiasm for interactive mobile learning, while 88.2% welcomed the integration of Minangkabau cultural content, a finding with significant implications for the Ethno-Meaningful Learning design.

Student interview data revealed three primary reading difficulties: (1) difficulty identifying the general definition and partial description components of observation report texts, particularly when the described objects are unfamiliar; (2) inability to construct inferences when explicit textual markers are absent; and (3) lack of motivation stemming from the perceived irrelevance of text topics to students' daily lives. One student stated, "When the text talks about things I have never seen, I just read the words without really understanding them. If it was about things from our culture here, I think I would understand more" (Student Interview, 2025).

Gap Analysis

A systematic gap analysis was conducted across five learning dimensions to identify the nature and magnitude of discrepancies between current conditions and ideal learning requirements.

Table 4. Gap Analysis: Current Conditions vs. Ideal Requirements in Reading Instruction

Dimensions	Current Conditions	Ideal Conditions	Gap
Method	Lectures and memorization dominant	Active, contextual, culture-based learning	Need for method innovation
Media	LKS and printed textbooks	AR-based interactive e-modules	AR media not yet available
Content	Generic text without local context	Texts rooted in Minangkabau culture	Lack of local text
Technology	Whiteboard and projector	Smartphones with interactive AR	Unused
Literacy	Surface/literal understanding	Critical and inferential understanding	Low literacy

The gap analysis presented in Table 4 reveals a systemic and multidimensional mismatch between current educational provisions and the requirements for effectively developing students' reading comprehension of observation report texts. The methodological gap reflects the

persistence of passive learning paradigms despite the Merdeka Curriculum's emphasis on student-centered, project-based, and contextual learning approaches. The media gap represents the most operationally significant finding: no AR-integrated module currently exists for reading instruction within the research context.

The content gap highlights the paradox of a culturally diverse region relying on culturally neutral texts, while the technology gap underscores the untapped potential of widespread smartphone ownership among students. In terms of urgency prioritization, the media gap is identified as the highest-priority concern, as the complete absence of AR-based learning tools directly limits technology-enhanced instructional innovation. This is followed by the methodological gap, which impedes meaningful engagement; the content gap, which may reduce student motivation; the literacy gap, which represents the ultimate learning outcome deficit; and the technology gap, which is partially mitigated by existing student smartphone ownership. This prioritization framework provides a targeted development roadmap for the Design phase.

Discussion

The integrated findings derived from teacher questionnaires, student questionnaires, structured interviews, and systematic gap analysis collectively establish a compelling and robust empirical foundation for developing an Interactive Augmented Reality Module grounded in the Ethno-Meaningful Learning approach. The convergence of quantitative and qualitative evidence across multiple respondent groups and data collection instruments substantially strengthens the internal validity of this conclusion, while simultaneously demonstrating that the identified learning challenges are not isolated phenomena but rather systemic patterns deeply embedded in the current instructional landscape of SMA Pembangunan Padang.

Theoretical Alignment and Pedagogical Rationale

The needs analysis findings align coherently with the theoretical framework underpinning the proposed development, lending further credibility to the intervention design. Vygotsky's sociocultural constructivism predicts that AR-mediated scaffolding will enable students to progress from their current level of actual reading competence toward a higher level of potential competence within their Zone of Proximal Development (ZPD). In practical terms, the interactive features embedded within the AR module (such as guided annotation, layered textual prompts, and three-dimensional visualization of text structures) function as dynamic scaffolds that gradually reduce cognitive support as students internalize comprehension strategies.

This scaffolded architecture is particularly critical given that the needs analysis revealed deficiencies not only at the literal comprehension level but also, more significantly, at the inferential level, where independent meaning-making is most cognitively demanding. Empirically, this interpretation is directly supported by the needs analysis finding that inferential comprehension achieved the lowest score (mean = 58.7) among all assessed dimensions, confirming that students' Zone of Proximal Development for reading comprehension is most pronounced precisely in the domain where Vygotskian scaffolding, operationalized through AR-mediated support, is theoretically most effective.

Ausubel's (2010) meaningful learning theory provides a complementary theoretical lens, suggesting that connecting new textual knowledge with culturally familiar objects will activate prior knowledge schemas and facilitate deeper, more durable comprehension. When students encounter an observation report text about the *rumah gadang*, for instance, they are not approaching an entirely unfamiliar subject; rather, they are anchoring new academic knowledge (regarding text structure, linguistic features, and logical connectives) to an existing cognitive framework shaped by cultural familiarity and lived experiences. This activation of prior schemas fundamentally transforms reading from a passive decoding exercise into an active meaning-construction process, which is precisely what current instructional approaches have failed to achieve.

Furthermore, Mayer's (2005) Cognitive Theory of Multimedia Learning provides the cognitive architecture rationale for AR's dual-channel processing advantages. According to this theory, learning is most effective when visual and auditory information channels are engaged simultaneously and coherently, as this reduces extraneous cognitive load while maximizing germane cognitive processing. The AR module's capacity to present textual content alongside

dynamic visual representations (such as animated diagrams of text structures, three-dimensional cultural objects, and embedded audio narration) directly operationalizes Mayer's principles of multimedia design. For students who have historically struggled with abstract structural understanding of *laporan hasil observasi* (LHO) texts, this multimodal presentation format offers a cognitively optimized pathway to comprehension that conventional print-based materials fundamentally cannot replicate.

Cultural Responsiveness as a Motivational and Cognitive Catalyst

The finding that 88.2% of students expressed receptivity to culturally grounded learning content is among the most significant results of this needs analysis, and its implications for module design deserve careful elaboration. This figure is not merely an indicator of preference; rather, it constitutes empirical evidence that cultural contextualization functions simultaneously as a motivational catalyst and a cognitive facilitator. It empirically supports Sudarmin (2019) theoretical argument that Ethno-Meaningful Learning creates motivational and cognitive bridges between abstract textual knowledge and concrete cultural experiences, effectively narrowing the perceived distance between academic content and students' personal worlds.

The Minangkabau philosophy of *alam takambang jadi guru* (the universe as teacher) provides an authentic and epistemologically coherent framework for observation report texts, which, by definition, require learners to observe, analyze, and systematically report phenomena in the natural and social world. This philosophical tradition, deeply embedded in the cultural consciousness of Minangkabau students, is not merely a decorative element appended to the module; rather, it constitutes the epistemological foundation of the entire learning experience. When students understand that observing the world and transforming those observations into structured, objective language represent forms of ancestral wisdom, the LHO text ceases to be an arbitrary academic exercise and becomes an extension of a living cultural practice. This reframing has profound implications for student engagement, persistence, and ultimately, comprehension depth.

Moreover, the integration of Minangkabau cultural objects (including, but not limited to, the *rumah gadang*, *tari piring*, *randai* performing arts, and the *nagari* governance system) as substantive content for observation report texts within the module addresses what Gay (2018) identifies as the cultural mismatch problem: the disconnect between school knowledge and students' lived cultural realities that systematically undermines academic motivation and performance. By rendering this cultural content visible, valued, and central to formal learning, the module enacts a form of cultural affirmation that research consistently associates with improved academic self-efficacy and reading motivation (Ladson-Billings, 2021; Paris, 2012).

Regarding transferability, although the specific cultural content is grounded in Minangkabau heritage, the Ethno-Meaningful Learning framework can be systematically adapted to other Indonesian ethnic contexts (including Javanese, Sundanese, Balinese, and Dayak communities) by substituting Minangkabau cultural objects with locally relevant equivalents while preserving the same pedagogical architecture. This transferability potential substantially broadens the implications of the present research beyond its specific geographic context.

Quantitative Evidence of Learning Gaps and Targeted Intervention

Document analysis of school records provided an additional, independently sourced layer of quantitative evidence that reinforces the urgency of targeted intervention. Students' average scores on observation report text comprehension assessments were recorded at 62.4, falling measurably below the Minimum Mastery Criterion (*Kriteria Ketuntasan Minimal*/KKM) of 75; a gap of 12.6 points that cannot be attributed to individual variation alone but instead reflects a pattern of systemic instructional insufficiency. More specifically, inferential comprehension recorded the lowest score among all assessed dimensions, with a mean score of 58.7, confirming that students' difficulties are most pronounced precisely in areas requiring higher-order reading competencies.

This finding has direct and specific implications for module design. Inferential comprehension (the ability to derive meanings that are not explicitly stated in a text, recognize implicit relationships between ideas, and draw conclusions from textual evidence) is the

dimension most closely associated with critical reading literacy and is the competency most urgently demanded by both the *Merdeka Curriculum* and the PISA reading literacy framework (OECD, 2023; Kemendikbudristek, 2023). It is also the dimension in which AR's capacity for visual representation of implicit relationships offers the most distinctive and pedagogically valuable contribution. By rendering abstract inferential relationships visible (for example, through animated connectors that illustrate how a general definition logically implies the partial descriptions that follow) the AR module can externalize cognitive processes that proficient readers perform internally but struggling readers have not yet fully developed.

The gap between literal and inferential comprehension scores also suggests that students possess adequate decoding and surface-level comprehension skills but lack the strategic reading repertoire required to move beyond the explicit surface meaning of a text. This finding implies that the module should be designed not merely to present cultural content attractively but also to explicitly teach and scaffold inferential reading strategies, including identifying textual presuppositions, drawing logical conclusions from partial evidence, and recognizing the organizational logic that connects the structural components of *Laporan Hasil Observasi* (LHO) texts.

Addressing Multiple Gaps Through an Integrated Intervention

These findings strongly resonate with the broader national and international literature on reading literacy. Indonesia's consistently low PISA scores across multiple assessment cycles OECD (2023) reflect a deep-seated and systemic reading comprehension deficit that cannot be meaningfully addressed through marginal improvements to conventional instructional approaches. Comparatively, Hsu (2021) demonstrated that AR-based language learning significantly outperformed conventional instruction in college English contexts, with effect sizes indicating practically significant learning gains.

Similarly, Garzón (2019) meta-analysis of 28 experimental studies found that AR consistently generated moderate-to-large learning effects across educational levels. These international findings, combined with the present needs analysis evidence, establish a compelling convergent case for AR's potential to address Indonesia's persistent reading comprehension challenges. Crucially, the integration of Ethno-Meaningful Learning in the present study adds a culturally responsive pedagogical layer that is theoretically expected to enhance AR's motivational and cognitive benefits for Minangkabau students. The evidence from this needs analysis corroborates what literacy researchers have long argued: transformative improvement in reading comprehension requires transformative intervention—innovative, technology-enabled, culturally responsive, and pedagogically principled approaches that fundamentally reconceptualize the reading learning experience (Duke & Cartwright, 2021).

The AR module grounded in Ethno-Meaningful Learning is uniquely positioned to address all four identified instructional gaps simultaneously and in an integrated manner. Regarding the media gap, the module provides interactive multimodal learning experiences that engage visual, textual, and kinesthetic modalities in ways that static print media cannot; students interact with three-dimensional cultural objects, navigate layered textual structures, and receive immediate visual feedback on their comprehension.

Regarding the content gap, the module contextualizes all learning activities within Minangkabau cultural objects and practices, ensuring that the subject matter of observation report texts is immediately recognizable, personally relevant, and culturally affirming. Regarding the technology gap, the module leverages existing smartphone infrastructure, which both teacher survey data and student questionnaire responses confirm is already prevalent within the school community, thereby reducing the resource acquisition barriers that have historically impeded technology integration in Indonesian secondary schools. Regarding the method gap, the module embeds explicit instruction in active comprehension strategies (including structural analysis, inferential questioning, and reflective summarization) within every learning activity, moving students from passive consumption of textual information toward active and strategic engagement.

Implications for the Design Phase

Collectively, these findings carry specific and actionable implications for the subsequent

Design phase of the 4D model. The module should be structured around a progression from culturally familiar concrete objects to abstract textual structures, operationalizing Ausubel's assimilation theory within its sequencing logic. Each learning unit should explicitly identify the targeted inferential comprehension subskills and embed scaffolded AR interactions designed to develop those specific abilities.

The selection of cultural content should be conducted in close consultation with local cultural experts and community stakeholders to ensure authenticity and avoid superficial or stereotypical representations of Minangkabau culture. User interface design should be guided by Mayer's (2005) multimedia design principles (particularly the coherence, signaling, and segmenting principles) to minimize extraneous cognitive load and maximize the instructional efficiency of each AR interaction. Finally, the module's formative assessment components should be designed to specifically measure growth in inferential comprehension, providing empirical data necessary to evaluate the module's effectiveness during the validation process in the Develop phase.

The needs analysis presented in this study does not merely document a problem; rather, it maps the precise contours of that problem in sufficient detail to guide the design of a solution that is theoretically sound, empirically grounded, culturally authentic, and technologically appropriate. The convergent evidence derived from multiple data sources and theoretical frameworks provides a strong foundation for asserting that the proposed AR module based on Ethno-Meaningful Learning constitutes not only a plausible but also a necessary response to the reading comprehension challenges faced by students at SMA Pembangunan Padang.

CONCLUSION

This needs analysis study has systematically documented a multi-dimensional gap between current reading comprehension instruction for observation report texts and the requirements for effective, meaningful, and engaging learning at SMA Pembangunan Padang. The study employed questionnaires, interviews, and document analysis involving nine teachers and 34 students, triangulating data sources to ensure the robustness of the findings.

Five critical findings emerged: (1) instructional methods remain overwhelmingly conventional and passive; (2) no interactive digital module integrating local culture currently exists in this context; (3) students strongly prefer mobile-based interactive learning and culturally relevant content; (4) students have no prior experience with AR-based learning; and (5) a significant gap exists between current reading achievement (mean = 62.4) and the minimum mastery criterion. These findings converge to establish a strong empirical foundation for the subsequent design and development of an Interactive Augmented Reality Module based on Ethno-Meaningful Learning.

The proposed module is theoretically grounded in Vygotsky's (1978) sociocultural constructivism, Ausubel's meaningful learning theory, Mayer's Cognitive Theory of Multimedia Learning, and ethnopedagogical principles derived from Minangkabau cultural wisdom. The integration of AR technology with Ethno-Meaningful Learning represents a novel contribution to Indonesian language education research and practice, an integration that, as confirmed by this needs analysis, directly responds to empirically identified educational needs.

The scientific contribution of this study lies in three dimensions: (1) it provides the first empirically grounded needs analysis integrating AR technology, Ethno-Meaningful Learning, and Minangkabau cultural epistemology within a unified framework for reading comprehension module development; (2) it establishes a replicable methodology for culturally responsive instructional needs analysis in diverse Indonesian regional contexts; and (3) it offers a theoretically coherent, data-driven foundation for developing technology-enhanced reading media that transcends the limitations of purely technical or purely cultural approaches to literacy instruction.

For future research, the findings of this needs analysis will guide the design, development, expert validation, and empirical testing of the AR module through limited and field trial phases. Researchers in other regions are encouraged to conduct comparable needs analyses that contextualize learning media development within their respective local cultural epistemologies, thereby advancing the broader agenda of culturally responsive technology-enhanced language

education in Indonesia.

The primary implications of this study extend to four domains: (1) for curriculum developers, the findings provide an evidence base for integrating culturally grounded AR modules into the Merdeka Curriculum framework; (2) for teachers, the identified gaps offer concrete guidance for redesigning reading instruction toward active and culturally responsive pedagogical approaches; (3) for educational technology designers, the needs analysis framework establishes design principles for developing AR applications that prioritize cultural authenticity alongside technical functionality; and (4) for future researchers, the 4D model framework provides a systematic template for conducting needs-analysis-driven instructional media development across diverse Indonesian regional contexts.

ACKNOWLEDGEMENT

The authors sincerely thank the Principal, Indonesian language teachers, and students of SMA Pembangunan Padang for their valuable participation, cooperation, and support throughout the data collection process. The authors also express their gratitude to Universitas Negeri Padang for providing academic support that facilitated the completion of this research. Finally, the authors appreciate all individuals who contributed to the successful completion of this study.

AUTHOR CONTRIBUTION STATEMENT

Atika Zikri conceptualized the study, designed the research, collected and analyzed the data, interpreted the findings, and prepared the original manuscript. Afnita contributed to the research methodology, supervised the study, critically reviewed the manuscript, and refined the academic content. Syahrul Ramadhan contributed to the conceptual framework, interpretation of the findings, and critical revision of the manuscript. Nursaid contributed to the validation of the research design, manuscript editing, and final approval of the version to be published. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

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