

# Developing Deep Learning–Based Digital Instructional Materials for Scientific Writing Integrating Palembang Local Wisdom to Enhance Secondary School Students’ Literacy

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**Abstract**—This study aims to analyze the need for developing digital instructional materials for scientific writing based on deep learning principles and Palembang local wisdom for secondary school students. The needs analysis was conducted using Nation and Macalister’s framework, which encompasses the aspects of necessities, lacks, and needs. The study employed a research and development (R&D) design. Data were collected through questionnaires and interviews, involving 779 secondary school students and 28 Indonesian language teachers as respondents. The data were analyzed using both quantitative and qualitative approaches. The findings indicate a strong need for the development of digital instructional materials for scientific writing that integrate deep learning principles and Palembang local wisdom. In terms of necessities, students require mastery of scientific writing conventions, the ability to develop ideas systematically, the use of appropriate academic language, and learning activities that foster critical and reflective thinking within a relevant local wisdom context. Regarding lacks, the instructional materials currently in use are predominantly theoretical, less engaging, unsystematic, limited in practical exercises and feedback, and do not optimally integrate technology or local wisdom, resulting in suboptimal development of students’ writing skills. Concerning needs, both teachers and students expressed a high demand for interactive, applicable, and contextual digital instructional materials, equipped with step-by-step guidance, authentic assessment, and adequate technical support to enhance the quality of scientific writing instruction in the digital era.

**Index Terms**—needs analysis, digital instructional materials, scientific writing, deep learning, local wisdom

## I. INTRODUCTION

Scientific literacy among secondary school students remains a serious challenge in 21st-century education (Zaidi & Sah, 2024). Findings from the Programme for International Student Assessment (PISA) indicate that Indonesian students’ literacy levels, including their scientific reading and writing abilities, are still below the international average (Fa et al., 2024; Nisphi et al., 2023). At the same time, the digital era requires students not only to comprehend information but also to organize ideas logically, critically, and scientifically (Kurniawati et al., 2024; Stutchbury et al., 2023; Bourbour, 2023). Consequently, learning approaches that are capable of accommodating these demands are urgently needed. In this regard, the deep learning approach is particularly relevant, as it emphasizes meaningful, reflective, and collaborative thinking processes (Kovač et al., 2023).

In addition, the growing emphasis on cultural preservation in education highlights the importance of integrating local wisdom into instructional materials, enabling students to learn within contexts that are closely connected to their everyday lives (Ottu et al., 2024; Yulianeta et al., 2024). The local wisdom of Palembang City, which embodies rich historical, social, and environmental values, has strong potential to serve as a contextual and meaningful learning resource (Jaya et al., 2022; Hakimah et al., 2021). However, digital instructional materials that integrate deep learning principles with such local wisdom remain scarce, particularly in the context of scientific writing instruction. Most

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existing materials are still predominantly textual and teacher-centered and do not optimally utilize digital technology or local cultural resources as learning media.

The integration of deep learning and local wisdom in the development of digital instructional materials offers significant potential for enhancing students' literacy. Deep learning focuses on the development of higher-order thinking skills, such as analyzing, evaluating, and creating, thereby encouraging students to achieve a deeper understanding of learning content rather than merely memorizing information. Meanwhile, local wisdom provides authentic cultural contexts that are relevant to students' lived experiences, making learning more meaningful while fostering awareness of local identity and values. By combining these two approaches, digital instructional materials function not only as tools for information delivery but also as media for developing critical and creative literacy. Students are encouraged to process information, relate it to local wisdom, and express their ideas through scientific writing. This synergy contributes to the comprehensive enhancement of students' literacy, encompassing comprehension, critical thinking, and writing skills.

Previous studies have demonstrated that deep learning approaches in education effectively promote critical thinking, complex problem-solving, and deep knowledge construction (Kovač et al., 2023; Fauziati et al., 2025; Learning, 2025). Similarly, the integration of local wisdom into digital instructional materials not only strengthens students' cultural identity but also increases learning engagement, as students feel more connected to the learning context (Sihombing et al., 2025; Widiastuti et al., 2024; Kusuma, 2022). Furthermore, the use of digital technology in instructional materials has been shown to enhance literacy learning effectiveness by presenting interactive and adaptive content (Nugraheni & Riyanto, 2023; Nieto-Márquez et al., 2020; Al-Fitrie et al., 2023; Maisarah et al., 2022). Nevertheless, studies that specifically focus on developing digital instructional materials for scientific writing based on deep learning and the local wisdom of Palembang City remain very limited. Therefore, this study holds high urgency as a technological, cultural, and pedagogical innovation aimed at improving secondary school students' scientific literacy. The findings are expected to contribute to both the enhancement of scientific literacy and the preservation of regional culture through a transformative technological approach.

The novelty of this study lies in the development of digital instructional materials for scientific writing that integrate deep learning principles with the local wisdom of Palembang City. This novelty is reflected in the combination of deep conceptual understanding, the application of local cultural values, and the use of interactive digital media to foster students' scientific literacy holistically. To the best of the authors' knowledge, such an approach has not previously been applied in the development of scientific writing instructional materials at the secondary school level. This claim is supported by prior studies, which have predominantly focused either on the development of digital scientific writing materials using deep learning approaches alone (Bal & Öztürk, 2025; Xu et al., 2025) or on the integration of local wisdom without incorporating deep learning principles (Kusuma, 2022; Yuliarti et al., 2023). Accordingly, this study contributes to strengthening cultural identity while simultaneously enhancing students' critical, reflective, and communicative thinking skills.

This study forms part of a research and development (R&D) project, specifically focusing on the information-gathering stage as the foundation for developing digital instructional materials for scientific writing based on deep learning and local wisdom. Information was collected through a needs analysis of students and teachers in Palembang City regarding the instructional materials to be developed. The needs analysis stage is crucial in instructional material development, as it ensures that the resulting product is relevant, appropriately targeted, and capable of addressing real classroom challenges. To analyze the needs of teachers and students, this study employed the needs analysis framework proposed by Nation and Macalister, which includes the aspects of necessities, lacks, and needs (Macalister & Nation, 2019). Accordingly, the research question guiding this study is: What are the needs of students and teachers in the development of digital instructional materials for scientific writing based on deep learning and the local wisdom of Palembang City to enhance students' scientific literacy?

## II. RESEARCH METHODOLOGY

### A. Research Design

This study employed a Research and Development (R&D) approach. It constitutes part of the research and information-gathering stage within the Research and Development model proposed by Borg and Gall (1983) (see Figure 1).

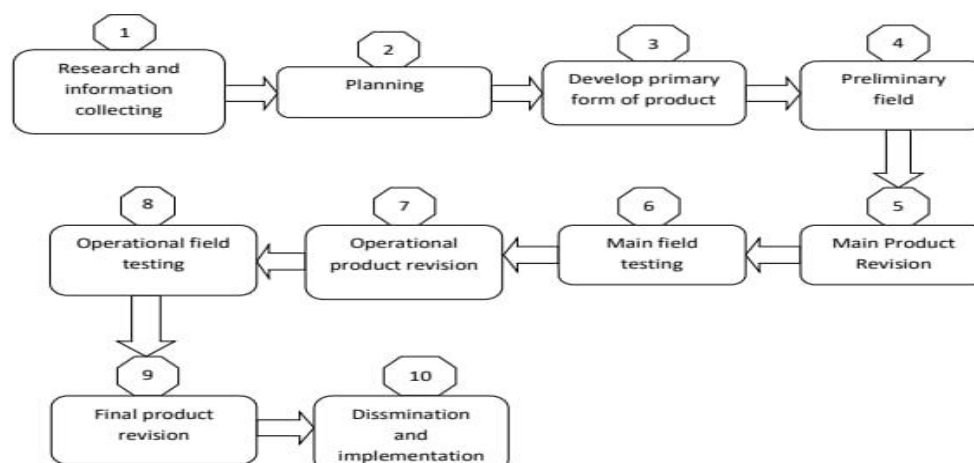


Figure 1. Stages of Research and Development

This stage aims to obtain preliminary data as the foundation for product development. Accordingly, the present study is situated at the first stage of the R&D process, focusing on a needs analysis of secondary school students and teachers in Palembang City regarding the development of digital instructional materials for scientific writing based on deep learning and local wisdom. The needs analysis framework adopted in this study is based on Nation and Macalister's model, which comprises three core components: necessities, lacks, and needs (Macalister & Nation, 2019; Oktorina et al., 2023). These components were employed to obtain a comprehensive understanding of the actual requirements of instructional material users.

#### B. Research Participant

The research participants consisted of 779 secondary school students (359 male and 420 female) and 28 Indonesian language teachers (6 male and 22 female) from secondary schools in Palembang City.

#### C. Data Collection Techniques

Data were collected using interviews and questionnaires. The interviews were conducted with six Indonesian language teachers and six secondary school students, with the interview questions focusing on the components of needs analysis, namely necessities, needs, and lacks. The questionnaires were distributed to both students (779 secondary school students) and teachers (28 Indonesian language teachers) through the Google Form platform. The content validity of the instruments was established through an expert judgment process involving three experts in educational research and digital learning. The experts evaluated the questionnaire items in terms of relevance, clarity, and alignment with the research objectives. Their feedback was used to revise wording and refine the instrument indicators. Furthermore, to ensure instrument reliability, a pilot study was conducted with 45 respondents who were not included in the main research sample. Internal consistency reliability was analyzed using Cronbach's alpha coefficient. The results indicated that Cronbach's alpha values ranged from 0.81 to 0.89 across all constructs, demonstrating good reliability and exceeding the commonly recommended minimum threshold ( $\alpha \geq 0.70$ ). To clarify the research instruments, the questionnaire blueprints are presented in Table 1.

TABLE 1  
QUESTIONNAIRE BLUEPRINT FOR NEEDS ANALYSIS OF STUDENTS AND TEACHERS

| No.   | Indicator  | Questionnaire Items                          |
|-------|--|--|
| Needs |  |  |
| 1.    | Learning objectives of scientific writing in digital instructional materials   | 1,2,3,4,5                                    |
| 2.    | Learning content in digital instructional materials  | 6,7,8,9,10                                   |
| 3.    | Presentation of instructional media in digital instructional materials   | 11,12,13,14,15,16,17,18,19                   |
| 4.    | Integration of deep learning in instructional materials:<br>a) Deep understanding<br>b) Critical analysis<br>c) Interconnection among concepts<br>d) Reflection and metacognition<br>e) Knowledge transfer | 20,21,22,23,24,25,26,27,28                   |
| 5.    | Learning evaluation in digital instructional materials   | 29,30,31,32,                                 |
| 7.    | Integration of local wisdom in digital instructional materials   | 33,34,35,36,37,38                            |
| 8.    | Technical support in digital instructional materials   |  |
| Lacks |  |  |
|       |  | Students (Item No.)      Teachers (Item No.) |
| 1.    | Presentation of instructional materials  | 8                      1,2,3,5               |
| 2.    | Learning structure   | 1,2,3,6,9            6,7,8,9,10              |
| 3.    | Instructional materials currently used   | 5,10                    7                    |
| 4.    | Integration of local culture in instructional materials  | 4                        4                   |
| 5.    | Learning evaluation  | 7                        8                   |

#### D. Data Analysis Techniques

The data were analyzed using quantitative and qualitative methods. Quantitative analysis was applied to questionnaire data using a four-point Likert scale, namely: *strongly needed, needed, less needed, and not needed, or strongly agree, agree, less agree, and disagree*. The criteria for determining the level of needs among teachers and students are presented in Table 2.

TABLE 2  
NEEDS CRITERIA

| No. | Mean Score Range | Category                         |
|-----|------------------|----------------------------------|
| 1   | 3.25–4.00        | Strongly Needed / Strongly Agree |
| 2   | 2.49–3.24        | Needed / Agree                   |
| 3   | 1.73–2.48        | Less Needed / Less Agree         |
| 4   | 1.00–1.72        | Not Needed / Disagree            |

### III. RESULTS

Needs analysis represents a fundamental stage in any research and development study, as the quality of the resulting product is highly dependent on the accuracy and relevance of information collected at this stage (Oktarina et al., 2023). Morrison et al. (2007) emphasize that needs analysis is a process of identifying gaps between actual learning conditions and the ideal conditions expected. These gaps may involve students' competencies, learning facilities, instructional strategies, media, and learning outcomes.

In the context of instructional material development, Nation and Macalister's framework provides a systematic analytical structure by categorizing needs into three main components: necessities, needs, and lacks. These components serve as analytical tools for understanding learners' requirements in the target language learning context. Data on needs were collected through questionnaires and interviews. The questionnaires were administered to secondary school students and teachers in Palembang City via Google Forms. A total of 779 students from four senior high schools (SMA) and 28 teachers from ten secondary schools participated in the questionnaire survey. In addition, interviews were conducted with six students and six Indonesian language teachers to deepen and validate the questionnaire findings. Interview data were used to support and strengthen the interpretation of users' needs in developing digital instructional materials.

#### A. Necessities

Necessities refer to the competencies, knowledge, and skills that learners must possess to succeed in a particular learning context, especially in the target situation. In the development of digital instructional materials for scientific

writing based on deep learning and the local wisdom of Palembang City, necessities encompass scientific literacy competencies, pedagogical principles, and technological features that must be incorporated to ensure academic validity and contextual relevance.

Based on interviews with six Indonesian language teachers, several key necessities were identified. First, in terms of scientific literacy competencies, the instructional materials must facilitate mastery of scientific writing structure, the ability to develop academic paragraphs, paraphrasing and citation skills in accordance with academic conventions, and the use of appropriate academic language. These aspects are essential as they form the foundation for systematic, valid, and ethical scientific writing. Second, the instructional materials must integrate deep learning principles by activating the six dimensions of deep learning (6Cs): critical thinking, creativity, communication, collaboration, character, and citizenship. These dimensions ensure that the writing process is not merely oriented toward knowledge reproduction, but toward meaning construction through critical analysis, creative idea development, collaboration, academic communication, internalization of academic ethics, and social and cultural awareness. Third, the integration of Palembang local wisdom constitutes an essential requirement in the development of instructional materials. This integration involves the presentation of local texts, phenomena, and cultural values, such as the historical heritage of Sriwijaya, Musi River culture, local economic practices, culinary heritage, and the social values embedded in the Palembang community. Emphasizing local wisdom functions not only as a source of learning content but also as a means of promoting cultural identity and contextualizing learning, thereby enabling students to construct scientific texts grounded in social and cultural realities that are closely aligned with their lived experiences. This need is supported by qualitative interview data from both teachers and students, which indicate that the use of local cultural contexts facilitates conceptual understanding and enhances student engagement and learning relevance. Fourth, as digital instructional materials, the developed product must feature an interactive, multimodal, and accessible learning interface, utilizing videos, infographics, interactive simulations, digital collaboration spaces, and online-based peer review mechanisms. Fifth, the materials should provide data-driven reading and writing activities, supported by authentic assessment rubrics, structured feedback, and self-reflection instruments to monitor students' competency development.

### B. Needs

The needs component refers to the actual requirements perceived by teachers and students in the development of digital instructional materials for scientific writing based on deep learning and the local wisdom of Palembang City to enhance students' scientific literacy. This needs analysis covers six components: learning objectives, content, media presentation, deep learning integration, learning evaluation, and local wisdom.

#### 1) Learning Objectives in Digital Instructional Materials

Learning objectives constitute the first component analyzed. Five statements were provided to students and teachers to identify their needs related to learning objectives in digital instructional materials. The results of the questionnaire analysis are presented in Table 3.

TABLE 3  
RESULTS OF STUDENT AND TEACHER QUESTIONNAIRE VIEWED FROM LEARNING OBJECTIVES IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement   | Students (Mean) | Category      | Teachers (Mean) | Category      |
|-----|---|-----------------|---------------|-----------------|---------------|
| 1   | Students are able to identify scientific writing topics based on Palembang local wisdom effectively.                                      | 3.11            | Needed        | 3.46            | Highly Needed |
| 2   | Students are able to collect data and information from various relevant digital sources to support scientific writing effectively.        | 3.34            | Highly Needed | 3.68            | Highly Needed |
| 3   | Students are able to develop a logical and systematic outline for scientific writing based on the selected topic.                         | 3.19            | Needed        | 3.50            | Highly Needed |
| 4   | Students are able to write a draft of a scientific paper in accordance with standard Indonesian language conventions and academic ethics. | 3.20            | Needed        | 3.64            | Highly Needed |
| 5   | Students are able to revise and edit scientific writing based on feedback from teachers or peers effectively.                             | 3.25            | Highly Needed | 3.57            | Highly Needed |
|     | Average   | 3.21            | Needed        | 3.57            | Highly Needed |

Based on Table 3, both students and teachers indicated that digital instructional materials should include learning objectives that enable students to: identify scientific writing topics based on Palembang local wisdom; collect data from relevant digital sources; organize logical and systematic writing outlines; write scientific drafts in accordance with Indonesian language conventions and academic ethics; and revise and edit scientific texts based on feedback from teachers or peers. The mean score of students' needs was 3.21 (*needed* category), while teachers' mean score reached 3.57 (*strongly needed* category), indicating a high demand for clearly formulated and well-directed learning objectives in digital instructional materials.

#### 2) Learning Content in Digital Instructional Materials

Learning content constitutes the second component examined in the needs analysis instrument. Five statements were provided to students and teachers to identify their needs related to the development of digital instructional materials from the content perspective. The results of the analysis are presented in Table 4.

TABLE 4  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON LEARNING CONTENT IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement  | Students (Mean) | Category        | Teachers (Mean) | Category        |
|-----|--|-----------------|-----------------|-----------------|-----------------|
| 1   | Digital instructional materials include theoretical content on the nature of scientific writing, its purposes, benefits, and writing stages. | 3.20            | Needed          | 3.71            | Strongly Needed |
| 2   | Digital instructional materials include scientific writing structures accompanied by examples based on Palembang local wisdom.               | 3.19            | Needed          | 3.75            | Strongly Needed |
| 3   | Digital instructional materials include guidance on citation and reference list construction using applications.                             | 3.20            | Needed          | 3.75            | Strongly Needed |
| 4   | Digital instructional materials include content on various forms of Palembang local wisdom.  | 3.19            | Needed          | 3.79            | Strongly Needed |
| 5   | Digital instructional materials include effective scientific writing strategies.   | 3.30            | Strongly Needed | 3.82            | Strongly Needed |
|     | Average  | 3.22            | Needed          | 3.76            | Strongly Needed |

Based on Table 4, both students and teachers indicated that they need to strongly need the learning content proposed in the needs analysis instrument. The content includes theoretical foundations of scientific writing, purposes and benefits of scientific writing, stages of scientific writing, scientific text structures accompanied by examples grounded in Palembang local wisdom, citation and reference management using digital applications, an introduction to various forms of Palembang local wisdom, and effective scientific writing strategies. The average need score for students was 3.22 (*needed*), while teachers reported a higher average score of 3.76 (*strongly needed*). These findings demonstrate that learning content is an essential component that must be comprehensively designed in the development of digital instructional materials.

### 3) Media Presentation in Digital Instructional Materials

Media presentation represents the third component in the needs analysis instrument. A total of nine statements were administered to students and teachers to explore their needs related to the forms of media presentation in digital instructional materials. The results of the analysis are shown in Table 5.

TABLE 5  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON MEDIA PRESENTATION IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement  | Students (Mean) | Category        | Teachers (Mean) | Category        |
|-----|--|-----------------|-----------------|-----------------|-----------------|
| 1   | Scientific writing materials are presented in clear, concise, and readable text.                   | 3.38            | Strongly Needed | 3.71            | Strongly Needed |
| 2   | Materials are presented using images, diagrams, or illustrations to support concept comprehension. | 3.34            | Strongly Needed | 3.75            | Strongly Needed |
| 3   | Materials include audio (narration or teacher explanations) to facilitate understanding.           | 3.25            | Strongly Needed | 3.68            | Strongly Needed |
| 4   | Materials include engaging video tutorials or step-by-step guidance for scientific writing.        | 3.29            | Strongly Needed | 3.86            | Strongly Needed |
| 5   | Materials include animations to explain thinking processes or scientific writing structures.       | 3.24            | Needed          | 3.79            | Strongly Needed |
| 6   | Materials include interactive scientific text examples.  | 3.25            | Strongly Needed | 3.68            | Strongly Needed |
| 7   | Materials are presented in the form of educational games.  | 3.29            | Strongly Needed | 3.79            | Strongly Needed |
| 8   | Materials include video tutorials on citation and reference writing using up-to-date applications. | 3.21            | Needed          | 3.68            | Strongly Needed |
| 9   | Materials include videos presenting Palembang local wisdom.  | 3.24            | Needed          | 3.71            | Strongly Needed |
|     | Average  | 3.28            | Strongly Needed | 3.74            | Strongly Needed |

As shown in Table 5, both students and teachers expressed high demand for learning materials presented through diverse media formats, including concise and readable texts, images and illustrations, audio narration, video tutorials, animations, interactive scientific texts, educational games, citation tutorials using current applications, and videos highlighting Palembang local wisdom. The average need score for students reached 3.28, while teachers reported an

average of 3.74, both categorized as *strongly needed*. These findings indicate that multimodal media presentation is a crucial aspect in supporting engaging and effective scientific writing instruction.

#### 4) Integration of Deep Learning in Digital Instructional Materials

The integration of deep learning constitutes the fourth component of the needs analysis instrument. Eight statements were administered to students and teachers to obtain information regarding their needs related to deep learning integration in the digital instructional materials to be developed. The results are presented in Table 6.

TABLE 6  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON DEEP LEARNING INTEGRATION IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement  | Students (Mean) | Category        | Teachers (Mean) | Category        |
|-----|--|-----------------|-----------------|-----------------|-----------------|
| 1   | Digital instructional materials help students understand scientific writing concepts deeply rather than merely memorizing rules. | 3.23            | Needed          | 3.79            | Strongly Needed |
| 2   | Digital instructional materials include writing exercises that encourage deep idea exploration.                                  | 3.25            | Strongly Needed | 3.68            | Strongly Needed |
| 3   | Digital instructional materials promote critical thinking in analyzing data or literature.                                       | 3.31            | Strongly Needed | 3.79            | Strongly Needed |
| 4   | Digital instructional materials require students to compare and evaluate various scientific sources.                             | 3.22            | Needed          | 3.75            | Strongly Needed |
| 5   | Digital instructional materials connect scientific writing concepts with knowledge from multiple disciplines.                    | 3.24            | Needed          | 3.71            | Strongly Needed |
| 6   | Digital instructional materials encourage reflection on writing strengths and weaknesses and promote self-improvement.           | 3.22            | Needed          | 3.71            | Strongly Needed |
| 7   | Digital instructional materials support the application of scientific writing skills in other contexts.                          | 3.22            | Needed          | 3.68            | Strongly Needed |
| 8   | Digital instructional materials include writing activities based on personal experience or local culture.                        | 3.22            | Needed          | 3.54            | Strongly Needed |
|     | Average  | 3.24            | Needed          | 3.71            | Strongly Needed |

The analysis reveals that both students and teachers need to strongly need the integration of deep learning in digital instructional materials. The average need score for students was 3.24 (*needed*), while teachers reported a higher average score of 3.71 (*strongly needed*). This integration encompasses learning activities that promote deep conceptual understanding, critical idea development, analysis and evaluation of scientific sources, interdisciplinary connections, reflective writing practices, application of writing skills across contexts, and the use of personal and local cultural experiences as foundations for scientific writing. These findings indicate that digital instructional materials should be designed to support meaningful learning and higher-order thinking.

#### 5) Integration of Local Wisdom in Digital Instructional Design

The integration of local wisdom constitutes the fifth component of the needs analysis instrument. Six statements were administered to students and teachers to explore their needs regarding the integration of Palembang local wisdom into digital instructional materials. The results of the analysis are presented in Table 7.

TABLE 7  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON THE INTEGRATION OF LOCAL WISDOM IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement   | Students (Mean) | Category        | Teachers (Mean) | Category        |
|-----|---|-----------------|-----------------|-----------------|-----------------|
| 1   | Themes of traditional Palembang cuisine   | 3.21            | Needed          | 3.61            | Strongly Needed |
| 2   | Themes of historical buildings in Palembang City  | 3.26            | Strongly Needed | 3.71            | Strongly Needed |
| 3   | Themes of Palembang ethnobotany   | 2.94            | Needed          | 3.50            | Strongly Needed |
| 4   | Themes of local traditions and traditional ceremonies in Palembang City                           | 3.26            | Strongly Needed | 3.71            | Strongly Needed |
| 5   | Themes of transportation and traditional floating houses ( <i>rumah rakit</i> ) in Palembang City | 3.16            | Needed          | 3.68            | Strongly Needed |
| 6   | Themes of creative economy and local handicrafts in Palembang City                                | 3.25            | Strongly Needed | 3.71            | Strongly Needed |
|     | Average   | 3.18            | Needed          | 3.65            | Strongly Needed |

Based on Table 7, both students and teachers reported moderate to high levels of need for integrating Palembang local wisdom into digital instructional materials. The average student need score was 3.18 (*needed*), while teachers reported a higher average score of 3.65 (*strongly needed*). The local wisdom themes considered most important include traditional cuisine, historical buildings, ethnobotany, local traditions and ceremonies, transportation and floating houses, and creative economy and handicrafts distinctive to Palembang City. These findings affirm that local cultural contexts are perceived as relevant and meaningful in scientific writing instruction.

### 6) Evaluation in Digital Instructional Materials

Evaluation is a critical component of digital instructional materials. Four statements were administered to students and teachers to identify their needs related to learning evaluation. The results are presented in Table 8.

TABLE 8  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON EVALUATION IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement  | Students (Mean) | Category | Teachers (Mean) | Category        |
|-----|--|-----------------|----------|-----------------|-----------------|
| 1   | Evaluation or practice activities are conducted individually                                       | 2.86            | Needed   | 3.46            | Strongly Needed |
| 2   | Evaluation or practice activities are conducted in groups  | 3.23            | Needed   | 3.46            | Strongly Needed |
| 3   | Evaluation is based on writing projects that produce written products                              | 3.04            | Needed   | 3.68            | Strongly Needed |
| 4   | Evaluation uses interactive applications and e-learning platforms that enhance learning motivation | 3.24            | Needed   | 3.79            | Strongly Needed |
|     | Average  | 3.09            | Needed   | 3.60            | Strongly Needed |

As shown in Table 8, both teachers and students expressed moderate to high levels of need for evaluation in the form of individual exercises, group-based activities, writing projects that result in tangible written products, and evaluations using interactive applications and e-learning platforms that enhance learning motivation. The average need score for students was 3.09 (*needed*), while teachers reported a higher average score of 3.60 (*strongly needed*). These findings indicate that authentic and technology-based assessment is a crucial element in scientific writing instruction.

### 7) Technical Support in Digital Instructional Materials

Technical support constitutes the final component analyzed in the development of digital instructional materials. Two statements were administered to students and teachers to identify their needs related to technical support. The results are presented in Table 9.

TABLE 9  
STUDENTS' AND TEACHERS' QUESTIONNAIRE RESULTS ON TECHNICAL SUPPORT IN DIGITAL INSTRUCTIONAL MATERIALS

| No. | Statement  | Students (Mean) | Category        | Teachers (Mean) | Category        |
|-----|--|-----------------|-----------------|-----------------|-----------------|
| 1   | Instructional materials are equipped with user guides in the form of text or video | 3.37            | Strongly Needed | 3.86            | Strongly Needed |
| 2   | Instructional materials are equipped with user-friendly navigation                 | 3.31            | Strongly Needed | 3.86            | Strongly Needed |
|     | Average  | 3.34            | Strongly Needed | 3.86            | Strongly Needed |

Based on Table 9, both students and teachers reported very high levels of need for technical support in digital instructional materials, including user guides in the form of text and video and navigation systems that facilitate ease of use. The average student need score was 3.34, while teachers reported 3.86, both categorized as *strongly needed*. These findings highlight that usability is a key factor in the successful implementation of digital instructional materials.

In addition to questionnaire results, interview data revealed a strong alignment between teachers' and students' needs in scientific writing instruction. Teachers emphasized the need for more structured, engaging digital instructional materials that help students understand fundamental concepts of scientific writing, particularly in idea development, effective sentence construction, mastery of standard academic vocabulary, and accurate use of punctuation. Meanwhile, students expressed a need for comprehensive and systematic learning materials to avoid confusion when initiating the writing process. They also expected the use of technology-based media, such as *Canva*, interactive presentations, and artificial intelligence tools, to support idea generation and improve writing quality. Both teachers and students agreed that the application of deep learning approaches and the integration of local wisdom closely related to their daily lives could enhance focus, motivation, and creativity in scientific writing learning.

### C. Lacks

Lacks constitute a crucial component and represent the final focus of the needs analysis. Data regarding existing gaps were collected through an online questionnaire administered via Google Forms to 779 students and 28 Indonesian language teachers in Palembang City. The results of the lack analysis from both student and teacher perspectives are presented in Table 10.

TABLE 10  
LACKS FROM THE STUDENTS' PERSPECTIVE

| No. | Statement   | Mean Score | Category   |
|-----|---|------------|------------|
| 1   | I still have difficulty determining a topic for scientific writing.   | 2.73       | Agree      |
| 2   | I have trouble in developing an outline for scientific writing.   | 2.66       | Agree      |
| 3   | I have trouble using references and citations according to proper conventions.                                      | 2.57       | Agree      |
| 4   | I rarely find scientific writing instructional materials that incorporate local culture.                            | 2.61       | Agree      |
| 5   | Learning at school does not use digital instructional materials.  | 2.07       | Less Agree |
| 6   | I have difficulty organizing ideas into systematic written texts.   | 2.58       | Agree      |
| 7   | I rarely receive detailed feedback from teachers in scientific writing.   | 2.27       | Less Agree |
| 8   | Scientific writing materials I have received focus more on theory than on practical exercises.                      | 2.54       | Agree      |
| 9   | Scientific writing instruction does not sufficiently train critical and reflective thinking.                        | 2.29       | Less Agree |
| 10  | My motivation to learn scientific writing is low because the instructional materials are not engaging.              | 2.49       | Agree      |
| 11  | Current instructional materials have not optimally promoted critical thinking and analysis of data and sources.     | 2.49       | Agree      |
| 12  | Current instructional materials only encourage limited reflection on the strengths and weaknesses of writing.       | 2.72       | Agree      |
| 13  | Current instructional materials do not require comparing multiple reference sources in scientific writing learning. | 2.52       | Agree      |

Based on Table 10, students agreed that they continue to face various difficulties in learning scientific writing, particularly in determining writing topics (2.73), developing outlines (2.66), using references and citations appropriately (2.57), and organizing ideas systematically (2.58). Students also acknowledged that existing instructional materials tend to emphasize theoretical explanations over practical writing exercises (2.54) and are not sufficiently engaging, which negatively affects their learning motivation (2.49).

Furthermore, students perceived that current instructional materials have not optimally fostered critical thinking, data analysis, and the effective use of academic sources (2.49), nor have they required students to compare multiple reference sources (2.52). The integration of local culture was also considered limited, as reflected in the statement that students rarely encounter scientific writing materials incorporating local cultural content (2.61). In contrast, students were less inclined to agree that schools do not use digital instructional materials (2.07), that they rarely receive detailed feedback from teachers (2.27), or that instruction does not train critical and reflective thinking at all (2.29). These findings suggest that digital materials and feedback practices already exist, but their implementation has not yet been sufficiently effective in addressing students' learning needs.

TABLE 11  
LACKS FROM THE TEACHERS' PERSPECTIVE

| No. | Statement  | Mean Score | Category   |
|-----|--|------------|------------|
| 1   | I find it difficult to design engaging scientific writing instructional materials for students.          | 2.54       | Agree      |
| 2   | I lack the competence to develop comprehensive instructional materials using up-to-date software.        | 2.29       | Less Agree |
| 3   | I have limited funding to develop digital instructional materials using current technologies.            | 2.68       | Agree      |
| 4   | I do not have sufficient time to develop engaging and comprehensive digital instructional materials.     | 2.25       | Less Agree |
| 5   | I rarely use scientific writing instructional materials that incorporate Palembang local culture.        | 2.36       | Less Agree |
| 6   | I rarely use digital instructional materials in scientific writing instruction.                          | 2.11       | Less Agree |
| 7   | Students experience difficulty organizing ideas into systematic written texts.                           | 2.50       | Agree      |
| 8   | I still frequently use conventional (printed) instructional materials in scientific writing instruction. | 2.54       | Agree      |
| 9   | I rarely provide detailed feedback in scientific writing instruction.                                    | 1.69       | Disagree   |
| 10  | Scientific writing materials I teach focus more on theory than practice.                                 | 1.89       | Disagree   |
| 11  | Scientific writing instruction does not sufficiently train students' critical and reflective thinking.   | 1.87       | Disagree   |
| 12  | Students' learning motivation is low because instructional materials are not engaging.                   | 2.25       | Less Agree |
| 13  | I have optimally implemented deep learning principles in scientific writing instruction.                 | 3.36       | Agree      |

Based on Table 11, teachers agreed that they still experience difficulties in designing engaging scientific writing instructional materials (2.54) and face financial constraints in developing digital instructional materials based on current technologies (2.68). Teachers also acknowledged that students experience difficulties in organizing ideas (2.50) and that

conventional printed materials are still frequently used in scientific writing instruction (2.54). Conversely, teachers tended to disagree or express limited agreement with statements related to technical incompetence (2.29), time constraints (2.25), limited use of local culture-based materials (2.36), and rare use of digital instructional materials (2.11). These findings indicate that the primary obstacles lie not in teachers' willingness or competence, but rather in systemic limitations and the lack of ready-to-use digital instructional materials. Teachers also disagreed that they rarely provide detailed feedback (1.69), that instruction is overly theoretical (1.89), or that scientific writing instruction does not train critical and reflective thinking (1.87). Moreover, teachers reported that they have implemented deep learning principles in scientific writing instruction (3.36), although this implementation is not yet fully supported by structured digital instructional materials. In addition to questionnaire results, interview data revealed that the primary deficiencies lie in instructional materials that have not fully addressed students' actual needs, particularly in linguistic accuracy, idea development, and effective use of technology. Teachers noted that existing instructional materials remain conventional, print-based, and insufficiently interactive, limiting their capacity to guide students through the scientific writing process in a gradual and systematic manner.

From the students' perspective, deficiencies were evident in the lack of step-by-step guidance, limited idea scaffolding, and insufficient applied exercises related to paragraph structure, document formatting, and scientific text analysis. Instructional materials were also perceived as less engaging, making it difficult for students to maintain focus and achieve deeper learning.

Overall, the most critical deficiency is the misalignment between instructional materials and the characteristics of digital-native learners. Students are already familiar with technologies such as artificial intelligence, Canva, and other digital media, yet without clear pedagogical guidance, the use of such technologies—particularly AI—risks becoming ineffective or inappropriate. Furthermore, Palembang local wisdom has not been optimally utilized as a source of ideas for scientific writing. Therefore, there is a strong need to develop structured, interactive, and contextual digital instructional materials, equipped with concrete examples, assessment rubrics, ready-to-use templates, language-focused exercises, and guided AI integration to support effective scientific writing instruction.

#### IV. DISCUSSION

Scientific writing competence is a crucial skill for secondary school students, as it fosters critical and analytical thinking in collecting, evaluating, and systematically presenting information (Oktarina, 2024). It also enhances written communication by enabling students to express ideas clearly while cultivating discipline and responsibility in managing data and sources. In language learning contexts, scientific writing contributes to the development of academic vocabulary, accurate sentence structures, and coherent argumentation, thereby strengthening overall language proficiency (Samad et al., 2024; Cahyono et al., 2024). Along with rapid technological advancement, digital instructional materials have become increasingly important in supporting scientific writing instruction, as they allow interactive writing models, broader access to academic references, and real-time feedback (Jeanjaroonsri, 2023; Fäth & Selenius, 2022). Consequently, scientific writing instruction supports not only academic achievement but also character formation, intellectual skills, language competence, and digital literacy.

The need to develop digital scientific writing instructional materials integrating deep learning and Palembang local wisdom was analyzed using Nation and Macalister's framework, encompassing necessities, lacks, and needs (Macalister & Nation, 2019). In terms of necessities, instructional materials should support mastery of academic writing conventions, paragraph development, paraphrasing and citation techniques, and appropriate academic language use. Deep learning principles should be embedded through the activation of the six core competencies (6Cs) to promote analytical, creative, collaborative, communicative, reflective, and ethical writing practices. In addition, integrating Palembang local wisdom—such as regional history, Musi River culture, traditional cuisine, and local social values—enhances contextual relevance and emotional engagement, encouraging students to explore cultural phenomena within their immediate environment (Ottu et al., 2024; Kusumaningrum & Masruro, 2022). As digital materials, learning platforms should provide interactive and multimodal features, including videos, infographics, online collaboration, and peer-review mechanisms, supported by authentic assessment rubrics, structured feedback, and self-reflection.

The findings indicate that both teachers and students demonstrate high levels of need for digital scientific writing instructional materials integrating deep learning and Palembang local wisdom. These needs include clear learning objectives, comprehensive and applicable content, and diverse interactive media to facilitate deep conceptual understanding. Deep learning integration is considered essential to ensure that students move beyond memorization toward critical analysis, evaluation, and idea development. Meanwhile, local wisdom integration enhances learning relevance and assists students in identifying meaningful writing topics. Quantitatively, the level of need ranged from 2.86 to 4.00 across learning objectives, content, media presentation, integration, assessment, and technical support, indicating categories of needed to highly needed. This confirms that existing instructional materials have not adequately met instructional demands, highlighting the urgency of developing new digital materials. These findings are consistent with previous studies emphasizing the effectiveness of digital-based language learning in enhancing student competence (Sinar et al., 2024; Ghani et al., 2022; Zaidi & Sah, 2024; Ruswandi et al., 2025).

Furthermore, the study reveals significant deficiencies in current scientific writing instruction in Palembang secondary schools. Students face difficulties in topic selection, outlining, idea organization, and appropriate use of

academic references. Existing materials are often overly theoretical, less engaging, and insufficient in fostering critical thinking, while limited practical exercises and step-by-step guidance contribute to students' confusion in developing scientific texts. Differences in perceptions between teachers and students regarding feedback, digital material utilization, and reflective learning indicate that current materials are not fully responsive to digital-era learning needs. Teachers also acknowledge constraints related to funding and technological resources, resulting in unsystematic availability of digital materials and inconsistent instructional quality across classrooms. Moreover, local wisdom has not been optimally utilized as a source of writing themes, despite evidence that its integration effectively enhances writing skills and student engagement (Kusuma, 2022; Ottu et al., 2024; Yuliarti et al., 2023). Therefore, scientific writing instructional materials should be developed in interactive digital formats, grounded in local wisdom, and supported by structured guidance and appropriate technology to improve students' scientific writing competence as well as their critical and reflective thinking skills.

## V. CONCLUSION

Based on the needs analysis, the development of digital scientific writing instructional materials integrating deep learning and Palembang local wisdom is an urgent necessity. In terms of necessities, secondary school students require mastery of scientific writing structures and conventions, systematic idea development, appropriate academic language use, and learning support grounded in deep learning principles to foster critical and reflective thinking. The integration of Palembang local wisdom is also essential to enhance contextual relevance and facilitate topic selection. Regarding lacks, current scientific writing instruction remains limited by instructional materials that are predominantly theoretical, less engaging, unsystematic, and insufficient in practical exercises, feedback, digital integration, and local wisdom utilization. These limitations contribute to students' low proficiency in topic selection, idea organization, and accurate application of academic conventions. In terms of needs, both teachers and students express a strong demand for interactive, applicative, and contextual digital instructional materials with clear learning objectives, comprehensive content, integration of deep learning and local wisdom, and authentic project-based assessment. Therefore, developing responsive digital scientific writing instructional materials is crucial for improving instructional quality, students' scientific writing competence, and critical thinking skills in the digital era.

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