

Needs analysis fo the development of web-based teaching materials in scientific writing skills instruction for eleventh-grade vocational high school students

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ABSTRACT

The development of students' scientific writing skills remains a significant challenge in vocational high schools, where conventional teaching materials often fail to accommodate students' technological learning preferences. This study aims to analyze the needs for developing web-based teaching materials to enhance the scientific writing skills of eleventh-grade vocational students. Utilizing a Research and Development (R&D) approach with the ADDIE model framework, this study involved two vocational school teachers and sixty eleventh-grade students in Bandung, Indonesia. Data were collected through teacher interviews and student questionnaires, then analyzed descriptively. The findings revealed that 63% of students experienced difficulties in scientific writing due to limited understanding of formal writing techniques, structuring arguments, and lack of digital learning resources. Teachers indicated the necessity for contextualized and interactive web-based learning platforms that align with the differentiated learning approach of the Curriculum Merdeka. Furthermore, over 80% of students expressed a preference for digital and interactive learning environments to improve their engagement and writing competence. The study concludes that the development of web-based portable-E teaching materials is essential to bridge the gap between students' needs and current teaching practices. The proposed innovation not only addresses students' difficulties in writing but also promotes independent learning, enhances digital literacy, and supports the achievement of curriculum goals. These findings offer valuable insights for future instructional material design and educational technology integration in vocational education contexts.

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Introduction

Writing skills are one of the language skills that need attention because they have a very important impact on life (Ventura et al., 2020). Writing activity is an action that can explore thoughts and feelings about certain objects that students choose to express in writing so that readers can understand them clearly (Meiliyana & Hikmat, 2022). Writing skills are a problem that is often encountered in schools due to the lack of student motivation in learning to write. This is evidenced by data from the National Literacy Trust (Best, 2024), interest in writing 34.6% for children and adolescents aged 8 to 18 years who stated that they enjoyed writing in their spare time. This figure has decreased by 12.2 percentage points over the past 13 years. Frequency of Writing, only 19.3% of children and adolescents write something every day in their spare time. Although this is a slight increase compared to the previous year, this figure has decreased by more than a quarter (28.5%) compared to 2010. This is also supported by the results of research from

(Challob et al., 2016; Ebadi & Rahimi, 2017; Li & Mak, 2022) that the decline in students' writing skills is due to the lack of free time and collaboration between students. This indicates that challenges in writing are not only a matter of interest, but also relate to students' limited critical and academic thinking competencies.

Problems related to writing learning in Vocational High Schools need to be resolved immediately by using learning materials that are in accordance with technology. In general, Vocational High Schools have provided adequate facilities and infrastructure, but teachers have not optimized them as a support for learning Indonesian. So that the teaching materials prepared are still centered on printed teaching materials provided by the government, even though students need the development of technological teaching materials to support learning.

With this situation, the general challenges in writing education become more complex in the vocational context, where there is a dual demand: mastery of practical skills and academic literacy. Therefore, solutions must be designed to not only meet curriculum goals, but also align with the distinctive characteristics and demands of vocational learning.

The preparation of teaching materials also requires special development, this is in accordance with (Sitanggang et al., 2023) teaching materials are positioned as tools or means to achieve competency standards and basic competencies. Teaching materials are also a form of service from educational units to students. In addition to digital-based teaching materials, learning methods are also needed that involve students actively and enjoyably which are adjusted to technological developments.

The development of technology has brought many benefits to education, especially in developing students' writing skills by providing access to extensive resources, sophisticated writing tools, collaboration opportunities, and personalized and flexible learning, technology helps students to become better and more confident writers. One of the technologies that helps students in learning is Web-based learning, or better known as web-based learning, is an educational method that utilizes the internet and web technology as the main media for delivering materials, interacting, and conducting evaluations.

This learning can be done synchronously (directly) or asynchronously (indirectly), and allows access to learning materials anytime and anywhere (Mishra & Sain, 2021). In addition, students are also trained to be more disciplined in managing time and managing tasks, because web-based learning requires them to be more independent (Bellhäuser et al., 2022; Dembo et al., 2013; Dos Santos et al., 2023; Mayer et al., 2021). Students have personal responsibility to follow the schedule, access materials regularly, and complete assignments according to the deadlines set and increase independence and skills.

One of the innovations in digital teaching material development is a platform called Portable-E. Portable-E is a prototype of web-based instructional material specifically designed to improve vocational high school students' scientific writing skills. It includes structured guidance, media-rich content, and collaborative tools tailored to students' academic and vocational needs.

The advantages of this Portable-E are that it allows more interactive and interesting learning with various features such as learning videos, simulations, and interactive quizzes, where students can understand the material in a more dynamic and varied way. This multimedia content can also help strengthen students' understanding, especially in subjects that require visualization of complex concepts. Portable-E has also been equipped with a discussion forum or chat feature that makes it easy for students to discuss, ask questions, and collaborate with classmates or even with teachers. Portable-E has great potential to improve students' learning experiences, and interactive teaching materials for students in learning in the technology era.

Based on previous research related to this research that can be used to obtain the State of the Art and as a supporting reference for research conducted by Nurhuda et al. (2024) on Listening Material for High School Grade X, the results of the study indicate that web-based teaching materials for listening to Indonesian are suitable for use by teachers and high school students in grade X. Furthermore, research conducted by Fauzan et al. (2022) the results of the study show that with the help of various web-based applications and platforms, poetry writing has succeeded in enabling teachers and students to teach and learn poetry in a constructive way. Research by Dayu & Aprilia (2022) explains that students show a significant increase in their ability to write learning-based modules after using the mind map approach.

However, none of these studies specifically address the development of web-based instructional materials that target scientific writing skills in vocational high schools. Most research to date has focused on creative or general writing improvement, whereas vocational students require specialized support to master formal, structured writing such as reports, project documentation, and research papers.

In line with the increasing demand for digital-based learning, there is an urgent need to develop web-based teaching materials that are contextually aligned with the real needs of students and teachers, especially in improving scientific writing skills in vocational schools. Given that current textbooks are still heavily dominated by mechanical activities and provide limited opportunities for the development of

students' creative and critical thinking skills (Huda et al., 2025), it is necessary to introduce alternative catalysts, such as web-based teaching materials, to better facilitate meaningful and adaptive learning experiences. The effective integration of technology into learning not only enhances student engagement but also significantly supports the achievement of learning (Akintayo et al., 2024; Rashid & Asghar, 2016; Wagino et al., 2024). In addition, the use of the web in the process of writing scientific papers not only facilitates access to information but also improves students' analytical, collaborative and digital literacy skills (Susanti et al., 2025). Therefore, this study becomes highly relevant in addressing the gap between current teaching practices and students' actual learning preferences.

Specifically, this study aims to answer three research questions: (1) How is the need for the development of web-based teaching materials viewed from the perspective of the curriculum? (2) How are these needs perceived from the perspective of students? (3) How are these needs perceived from the perspective of teachers? Through a comprehensive needs analysis, this research is expected to provide a strong foundation for designing web-based instructional innovations that are adaptive, engaging, and capable of enhancing scientific literacy among vocational students.

Method

This study uses the type of Research and Development (R&D) development research with the development model used is the ADDIE Model, consisting of 5 stages, namely Analysis, Design, Develop, Implement, and Evaluation as outlined by Branch (2009). The ADDIE model was selected due to its systematic and flexible structure for the development of instructional materials (Abuhassna et al., 2024; McKenney & Brand-Gruwel, 2023). The steps of the ADDIE model are explained in the Figure 1.

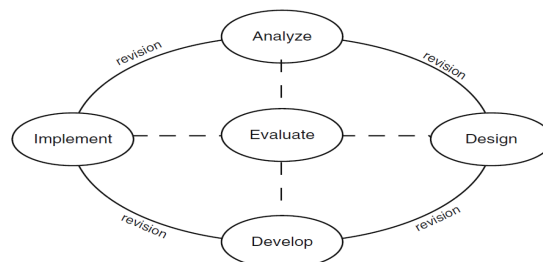


Fig. 1. The Steps of the ADDIE Model

However, it is important to note that this current study reports findings specifically from the Analysis phase of the ADDIE model. This phase was chosen due to its foundational importance in understanding learner needs, curriculum demands, and technological context before entering the design and development stages. The rationale for focusing solely on the analysis stage stems from the study's objective to construct a strong empirical foundation for subsequent development of the teaching materials. Reporting only the analysis phase allows for a focused and in-depth understanding of existing gaps, while future studies will extend into the Design, Development, Implementation, and Evaluation stages. By segmenting the ADDIE stages into distinct studies, the research maintains methodological clarity and allows each phase to be addressed rigorously.

Based on Figure 1, the research stages in the first stage are analyzing the product needs of an actual information search process that occurs in schools using instruments. First, the researcher carried out a curriculum analysis, namely an in-depth analysis of the independent curriculum used in a private Vocational High School (SMK) Bandung City, by analyzing Learning Achievements (CP) and Learning Objectives (TP). CP and ATP will be used as indicators in creating portable-E-based scientific writing skills teaching materials, student needs in writing scientific papers and teacher needs in preparing portable-E web-based teaching materials.

The study was conducted at a private Vocational High School (SMK) in Bandung City, Indonesia. The selected school has implemented the Kurikulum Merdeka since 2022 and is equipped with a stable internet connection, a computer lab, and LCD projectors in most classrooms, which facilitates the adoption of web-based learning. Teachers at the site have previously participated in professional development workshops on digital pedagogy, although their application of such tools in Indonesian language instruction remains minimal. Additionally, students have regular access to smartphones and are familiar with basic internet usage for learning, yet their experience in scientific writing remains limited to mechanical tasks such as summarizing and paraphrasing, without emphasis on argumentative structure or referencing. These contextual details support the relevance of this study and indicate the school's readiness to adopt innovative, technology-enhanced instructional materials.

Participants consisted of two Indonesian language teachers and sixty eleventh-grade students, selected using purposive sampling to ensure their direct involvement with scientific writing activities and the implementation of the Kurikulum Merdeka. Data were collected using teacher interview instruments and closed questionnaires for students. A semi-structured interview protocol was developed to explore teachers' perspectives regarding curriculum needs, challenges in teaching scientific writing, and their expectations for web-based instructional materials.

The design of both the interview protocol and the student questionnaire was grounded in the theoretical framework of needs analysis in instructional design, particularly informed by the works of Cohen et al. (2018). These frameworks emphasize the importance of identifying gaps between existing learner conditions and desired competencies as the foundation for designing effective instructional materials. Therefore, the interview protocol was structured to capture the institutional context, teacher challenges, instructional goals, and preferred formats of content delivery, while the student questionnaire focused on learner characteristics, digital readiness, and topic-specific writing challenges. The alignment of instrument items with these theoretical constructs ensured that the data collected directly informed the development of contextually appropriate web-based materials.

Qualitative data from teacher interviews were analyzed using thematic analysis, identifying recurring patterns and categories related to the instructional needs (Braun & Clarke, 2023, 2024; Terry & Hayfield, 2021). A closed-ended questionnaire was administered to identify students' difficulties in scientific writing, their preferences for digital learning materials, and their technology usage habits. The questionnaire employed a Yes and No format and was validated through expert judgment. Quantitative data from the questionnaires were analyzed descriptively using frequency distribution and percentage analysis (Creswell & Creswell, 2018).

To strengthen validity, triangulation was applied by comparing patterns that emerged from teacher interviews with student questionnaire responses. For instance, if teachers reported a lack of engagement due to the absence of interactive materials, this was validated against student responses regarding their preference for multimedia and web-based content. Moreover, the convergence and divergence of qualitative and quantitative findings were systematically analyzed to ensure coherence. Researcher reflexivity was also applied by maintaining a reflective journal during the data collection process to recognize potential biases. Member checking was conducted with the participating teachers to confirm the accuracy of interview interpretations, while expert review was utilized during instrument development to enhance content validity. These strategies collectively aimed to mitigate bias and enhance the reliability of the findings. So that, triangulation was employed to cross-validate findings from different data sources (Miles et al., 2014; Patton, 2014).

Results and Discussion

Analysis of Merdeka Curriculum (CP and TP)

The Merdeka Curriculum (Kurikulum Merdeka) is designed to foster student autonomy, creativity, and critical thinking through differentiated learning pathways. In this study, an analysis was conducted on the Learning Achievements/Content Standards (Capaian Pembelajaran/CP) and Learning Objectives (Tujuan Pembelajaran/TP) relevant to scientific writing instruction for eleventh-grade vocational school students can be seen in Table 1.

Table 1. Analysis of Learning Achievements and Learning Objectives

<i>Writing Learning Outcomes (CP)</i>	<i>Topics</i>	<i>Learning Objectives (TP)</i>
Students are able to write ideas, thoughts, views, metacognitive knowledge for various purposes logically, critically, and creatively. Students are able to write various types of literary works. Students are able to write self-reflection texts. Students are able to write research results, functional texts of the world of work, and development of further studies. Students are able to modify/deconstruct literary works for creative economic purposes. Students are able to publish their writings in print and digital media.	Scientific Writing	Presenting scientific work using the web based on an understanding of writing, images, and supporting graphic organizer tools (tables, maps, graphs, etc.).

From table 1 it is explained that according to Learning Outcomes (CP) in writing competency, students are expected to improve their logical, critical, and creative thinking skills to convey ideas, perspectives, and metacognitive knowledge in various contexts. In addition, students are expected to have the ability to write

research results, reflective texts, literary works, and functional texts for the world of work and further education development. They are also expected to have the ability to transform their literary works into the context of the creative economy. Thus, this achievement is reinforced by the expectation that students will have the ability to publish their work in a manner that is in accordance with the needs of the times, both in print and digital media. This confirms that the Merdeka Curriculum is driven by the need to improve human resources and adapt education to the rapidly changing global context, thus the importance of teacher readiness and the development of innovative teaching materials adapted to the new curriculum (Hadi et al., 2023).

The learning material used to achieve this achievement is scientific work. This material requires students to not only understand the structure and rules of writing scientific work, but also be able to integrate supporting elements such as images, tables, graphs, and other graphic tools as a form of systematic and interesting data presentation (Franconeri et al., 2021). Scientific work encourages high-level thinking skills because it requires data analysis, logical argumentation, and presentation of factual information that can be academically accounted for (Suprihatin et al., 2021).

The learning targets and materials studied are very much in line with the formulated learning objectives, namely presenting scientific work using web media based on an understanding of writing and supporting graphic tools. Because scientific work is delivered digitally on the internet, students not only need to have good writing skills; they also need to build skills for visual thinking, digital literacy, and the ability to convey scientific messages communicatively. Therefore, this learning objective aims to connect students' conceptual abilities (as stated in the CP) with application skills through digital media that are relevant and contextual to the needs of the times.

While the CP and TP documents of the Merdeka Curriculum emphasize students' autonomy in presenting scientific work using web-based formats and visual tools, empirical findings from teachers and students reveal a misalignment in practical readiness. For example, although the curriculum expects students to integrate graphics and publish their work digitally, student responses indicate limited understanding of the IMRAD format, and teachers express concern over students' ability to follow systematic scientific writing conventions. This highlights a gap between curriculum expectations and on-the-ground competencies, thus reinforcing the need for web-based teaching materials that not only fulfill curriculum demands but also scaffold foundational writing skills in a gradual, accessible manner.

Thus, the development of web-based teaching materials for scientific writing not only supports the attainment of CP and TP targets but also aligns with the core principles of the Merdeka Curriculum: autonomy, relevance, and holistic education. Embedding digital media into the process of scientific writing instruction provides a meaningful way to operationalize curriculum mandates while simultaneously enhancing students' 21st-century skills.

Student Needs Analysis

Analysis of student needs is a crucial step in designing effective teaching materials that are appropriate to the learning context. Based on the analyzed questionnaire data, several important aspects were found that reflect students' needs in developing scientific writing skills, which are summarized in Figures 2 and 3.

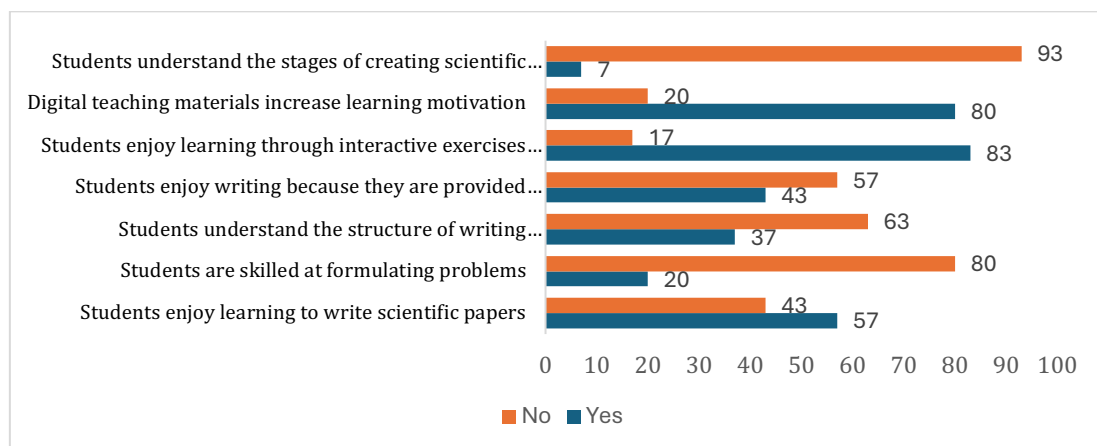


Fig. 2. Student Needs Questionnaire Responses in Learning Scientific Writing Skills

In total, 60 students participated in the questionnaire, and the response rates for each item were analyzed using descriptive statistics. For instance, 85.53% ($n=51$) reported difficulty with the IMRAD structure, while 73.33% ($n=44$) found academic vocabulary a major obstacle. The confidence interval for each proportion was calculated at 95%, suggesting that these findings are statistically representative of the student population at the selected school. These quantitative results validate the qualitative insights from teachers regarding student limitations in scientific writing. The statistical strength of the data supports the reliability of the identified needs and affirms the urgency of targeted instructional interventions.

Based on Figure 2, there are several important points that reflect students' needs in improving their scientific writing skills, including understanding the writing structure where students show limited understanding of scientific writing such as the IMRADCR (Introduction, Methods, Result and Discussion, Conclusion, Reference) format. This confirms previous findings that 85.53% of students had difficulty understanding the IMRAD format, especially in compiling the background, research methods and discussion of results (Nisa et al., 2023). This limitation can certainly hinder students' ability to compile systematic and logical scientific works.

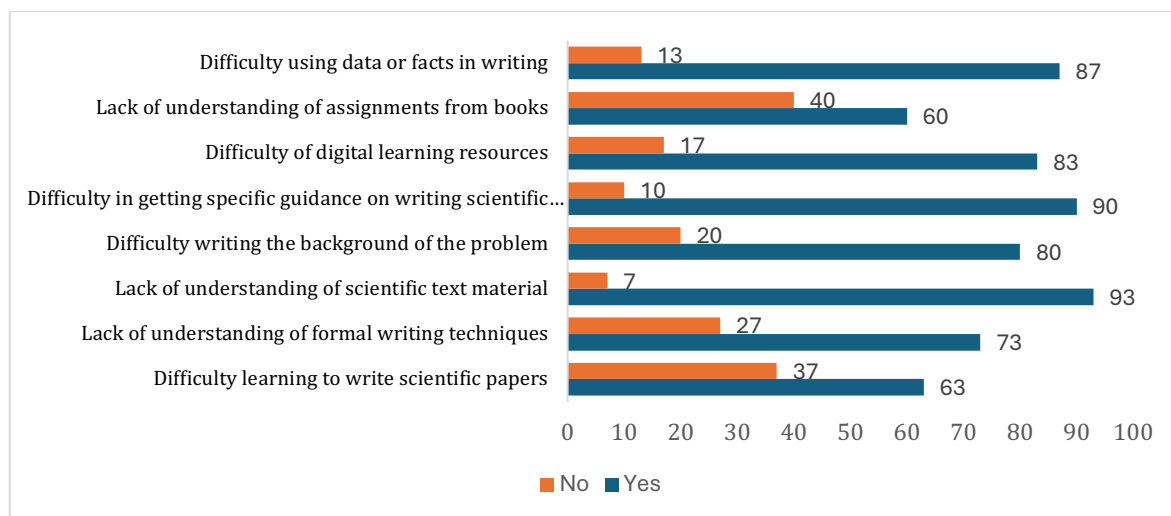


Fig. 3. Student Difficulty Analysis Response

Another important aspect of this finding is the limited vocabulary and mastery of academic language. The results of the questionnaire revealed that many students found it difficult to use appropriate vocabulary and appropriate academic language in scientific writing. This reflects the need for vocabulary enrichment and training in the effective use of academic language. Good mastery of academic language is essential to improve the quality of scientific writing (Alfianika et al., 2019).

The data also revealed that students need clear and structured guidance in the process of writing scientific papers, including concrete examples that can be used as references. This shows that students need teaching materials that are not only theoretical but also applicable and easy to understand. This emphasizes the importance of providing teaching materials based on students' real needs to increase learning effectiveness (Ghufron et al., 2016; Yundayani et al., 2017). Learning solely through traditional printed materials tends to limit students' critical thinking development and engagement, thus necessitating the integration of web-based or mobile teaching materials that offer flexible, interactive, and accessible learning experiences (Hasanudin et al., 2024).

In today's digital era, technology integration in learning is also a necessity that cannot be ignored. Students show high interest in the use of interactive and easily accessible digital platforms to support the learning process of writing scientific papers. The use of technology in learning scientific writing can significantly increase student motivation and engagement (Nisa et al., 2022). Another reason is that the use of conventional learning models that merely present sample texts without active engagement tends to make students passive and unmotivated, thus highlighting the urgent need for web-based teaching materials that can foster more interactive, creative, and independent learning experiences (Susilo et al., 2024).

In addition, students also highlighted the importance of constructive evaluation and feedback in the learning process. Students want an evaluation mechanism that can help them understand the strengths and weaknesses of their writing, as well as provide direction for improvement. This effective feedback can improve the quality of scientific writing (Hernawan et al., 2023). Thus, by considering the identified needs of students, the developed teaching materials are expected to increase the effectiveness of learning to write scientific papers and prepare students to face academic challenges in the future.

Teacher Needs Analysis

Analysis of teacher needs in preparing portable web-based teaching materials-E in the context of this study was obtained through direct interviews with vocational high school teachers. Based on the results of interviews with these teachers, the results are summarized in Table 2.

Table 2. Analysis of Teacher Needs Interview Results

<i>Category Findings</i>	<i>Interview Findings</i>	<i>Implications for Teaching Materials Development</i>
What (Expected challenges and targets)	Understanding of writing methodology and habituation of writing with correct spelling	The platform should provide interactive scientific paper templates and automatic spelling practice features (AI-based).
Who (Expected needs from the user's perspective)	Vocational high school students with varying abilities (low/high KKTP)	The design should be inclusive, for example, different levels of difficulty and audio-visual support for slow learners.
When (Expected needs based on time of use)	During classroom learning and independent assignments	Offline access and data synchronization features when connected to the internet.
Where (Expected needs based on location)	School and home	Optimize for mobile and desktop devices.
Why (Basis for Web-based Teaching Material Needs)	Efficiency, technological appeal, ease of access. The teaching materials used still rely on teaching modules and textbooks.	Prioritize a user-friendly and easy-to-access interface.
How (Needs for how to measure success)	Assessment rubrics, projects and presentations.	Include automated grading and digital portfolio features for student projects.

Some of the data presented reveal that the development of Portable-E Web-based teaching materials must be developed contextually, meaning that they are able to present case examples relevant to vocational school majors such as computer engineering, business, health, or management and others. The findings of this interview are in line with previous studies which explain that majority of vocational school students have difficulty writing scientific papers due to the lack of context-based training in the department (Anggara et al., 2021; Siregar et al., 2022). In interviews with teachers, data was also obtained that mastery of scientific writing is needed at least to write PKL reports and practical needs in society, so the urgency of developing this web-based teaching material is quite necessary.

Automated grading and automatic feedback features are also needed because they have been proven to increase writing motivation (Messer et al., 2024; Wilson & Roscoe, 2020). Despite the demands of various latest features, the teaching materials developed must still pay attention to efficiency and limitations, meaning considering infrastructure gaps and minimizing dependence on the internet and sophisticated hardware. Another thing is that teaching materials must support the independent curriculum, which means being able to facilitate differentiated learning through modular content.

Nevertheless, some contradictions emerged within the findings. While students expressed enthusiasm for digital learning, interviews with teachers raised concerns about their digital literacy levels and potential distractions from technology use. Similarly, although students requested interactive and multimedia materials, their varying ability levels—especially those with low KKTP—may hinder equal participation without proper scaffolding. These tensions indicate that any web-based instructional design must balance between interactivity and accessibility, and between learner autonomy and guided instruction. Furthermore, infrastructure disparities across vocational schools could present limitations in the implementation of the developed materials, particularly in schools with limited internet access or outdated devices. Acknowledging these limitations is essential for designing adaptable and inclusive solutions.

Conclusion

This study aims to analyze the need for the development of web-based teaching materials in learning scientific writing skills in class XI of Vocational High Schools. Based on the results of the analysis of the

curriculum, student needs, and teacher needs, it was found that students still face many challenges in understanding the structure of scientific papers, using academic language, and compiling arguments supported by data. On the other hand, teachers also conveyed the need for teaching materials that are able to optimize the technological facilities available in schools.

The questionnaire analysis showed that most students needed more interactive, flexible, and digital-based learning resources. The majority of students also showed a preference for web-based learning, which was considered more interesting, easily accessible, and able to provide real-time practice and evaluation. This confirms that the innovation of portable web-based teaching materials-E is not only a complement, but has become an urgent need to increase the effectiveness of learning to write scientific papers in vocational schools.

This study also emphasizes the importance of a learning approach that is not only oriented towards theory, but also applied, by providing concrete examples, step-by-step guides, and constructive feedback facilities. The integration of technology in learning is believed to help students be more independent, creative, and able to develop critical thinking skills through scientific writing. Thus, the development of portable web-based teaching materials-E must be designed by considering the actual needs of students and teachers, compatible with the Independent Curriculum, and responsive to developments in educational technology. It is hoped that the results of this study can be a basis for the development of learning innovations in the future, as well as contributing to improving the quality of scientific literacy in vocational education environments.

Declarations

- Author contribution** : Evi Susanti: Conceptualization, Methodology, Data Collection, Formal Analysis, Writing - Original Draft Preparation. Ade Hikmat: Supervision, Validation, Writing and Review. Wini Tarmini: Investigation, Data Curation, Writing and Review. All authors have read and agreed to the published version of the manuscript
- Funding statement** : This research did not receive any funding.
- Conflict of interest** : The authors declare no conflict of interest.
- Ethics Approval** : This study was conducted in accordance with ethical standards for educational research. Prior to data collection, verbal and written informed consent was obtained from all participating teachers and students. The participation was voluntary, and respondents were assured of the confidentiality and anonymity of their responses.
- Additional information** : No additional information is available for this paper.

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