Digitalization Strategy for Scientific Writing Assessment as an Effort to Improve the Quality of Indonesian Language Learning at STMIK Pelita Nusantara

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Abstract. The assessment of students^ scientific writing has predominantly been conducted manually, a practice that often leads to subjectivity, inconsistency, and delayed feedback. This study aims to design and implement a digitalization strategy in the scientific writing assessment process to enhance the quality of Indonesian Language instruction at STMIK Pelita Nusantara. The research adopts a Research and Development (R&D) methodology using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The developed digital assessment system integrates relevant academic writing indicators, including structural organization, logical reasoning, proper citation, and adherence to academic conventions. The system trial demonstrated improved efficiency in the assessment process, enhanced clarity of feedback provided to students, and a notable increase in the quality of students^ scientific writing, particularly in terms of structure and academic rigor. The findings recommend the adoption of a digital assessment system as a pedagogical innovation in Indonesian Language learning, especially within the context of vocational higher education.

Keywords: digital assessment, scientific writing, Indonesian Language, instructional quality, vocational education.

1 Introduction

The assessment of scientific writing skills in higher education has predominantly been carried out manually. This practice often results in subjectivity, inconsistency, and delays in providing feedback. Such conditions pose a serious challenge in Indonesian Language instruction, particularly in vocational higher education, as students require feedback that is timely, specific, and standardized to enable them to revise structure, argumentation, citation, and adherence to academic conventions on a continuous basis. Recent studies indicate that automated writing evaluation (AWE) can significantly reduce the time required to provide written feedback to students, thereby accelerating the revision cycle of their academic writing (Cotos et al., 2024) [1].

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In the context of the national education system, vocational education in Indonesia is currently directed towards enhancing curriculum relevance, improving quality standards, and strengthening partnerships with industry. Vocational education is considered vital because it is believed to reduce unemployment rates while simultaneously increasing national productivity (Rohim & Sari, 2025) [2]. In line with this, digital literacy and the integration of technology-based learning ecosystems are deemed crucial for vocational students to remain competitive in the era of digital transformation (Rahmat et al., 2025) [3].

For example, in the Scientific Writing course at STMIK Pelita Nusantara, lecturers are often responsible for reviewing dozens to hundreds of draft manuscripts. Although assessment rubrics are available, variations in interpretation among assessors frequently result in inconsistent scores and feedback. Moreover, feedback is often delivered several days or even weeks after submission, causing students to lose momentum in revising their work. The presence of a digital assessment system allows lecturers to upload standardized rubrics, map indicators (structural organization, logical reasoning, citation accuracy, and academic conventions), and provide immediate feedback. Such a system is not intended to replace the lecturer but to serve as a partner that accelerates routine tasks while reinforcing the lecturer's role in guiding substantive and reasoning aspects of student writing.

Nevertheless, the application of writing evaluation technologies must take into account the principles of fairness and accountability. A recent report from the U.S. Department of Education emphasizes that AI-based assessments for formative purposes must minimize bias, promote equity, and maintain the role of human involvement in the assessment process (U.S. Department of Education, 2023)[4]. Accordingly, the design of a digital assessment system should incorporate mechanisms for rubric auditing, transparency of criteria, and lecturer review of machine-generated recommendations.

To ensure a systematic development process, this study adopts a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The ADDIE model is widely applied in educational research because it is considered flexible, generic, and capable of producing structured instructional designs (Branch, 2023) [5]. Through ADDIE, the needs of writing assessment can be carefully identified, academic indicators can be modeled within the system, and the product can be tested gradually for both validity and effectiveness.

Furthermore, this study is designed to examine the validity of the product and its effectiveness of use. Product validity in educational development research encompasses two dimensions: content validity and construct validity. Content validity assesses the extent to which the digital assessment system truly reflects relevant learning indicators. In this case, the involvement of language experts, academic assessment specialists, and educational technology experts is essential to ensure that the integrated rubric accurately represents the targeted aspects of academic writing, namely structural organization, logical reasoning, citation accuracy, and adherence to academic conventions. Expert judgment was employed through Likert-scale validation sheets, analyzed using Aiken's V or Lawshe's Content Validity Ratio (CVR) to measure the degree of agreement among experts (Azwar, 2022) [6] [7]. Meanwhile, construct validity focuses on the alignment between indicators in the digital rubric and theoretical frameworks of writing assessment. For example, the indicator "structural organization" must be

consistent with rhetorical theory in academic writing, while the indicator "citation accuracy" must align with international academic standards (APA/IEEE). This approach ensures that the constructs employed within the digital system remain consistent with theoretically sound concepts of academic assessment (Sugiyono, 2021) [8].

Once product validity is established, the study proceeds to evaluate the effectiveness of the system in practice. Effectiveness is assessed in terms of its impact on student learning and lecturer efficiency. Several aspects are measured: (1) lecturer efficiency, indicated by the time required to provide feedback compared to manual methods; (2) clarity and usability of feedback, measured by the extent to which students can understand and apply the feedback to revise their work; (3) improvement in students' writing quality, analyzed by comparing pre-test and post-test writing outcomes using the same rubric; and (4) user responses, which capture lecturers' and students' perceptions of practicality, usefulness, and satisfaction with the system through questionnaires and interviews (Branch, 2023) [5].

Effectiveness testing is carried out in stages, beginning with a pilot test in one or two classes, followed by a field test to ensure broader generalizability. This approach is consistent with the evaluation phase of the ADDIE model, which emphasizes that educational development products should be assessed not only for theoretical validity but also for their effectiveness in real learning practices (Plomp & Nieveen, 2019) [9]. In this way, the study is expected to provide a comprehensive overview of both the alignment of the product with instructional objectives and its tangible impact on the quality of Indonesian Language learning in vocational higher education. Previous research on digital writing assessment has highlighted the potential of AWE systems in providing consistent and timely feedback. Warschauer and Grimes (2008) [10] found that AWE can improve the quality of students' revisions because it provides immediate feedback, although they emphasized the importance of the teacher's role as a mediator. Similarly, the study by Li, Link, and Hegelheimer (2015) [11] demonstrated that the integration of AWE into academic writing courses was able to enhance linguistic accuracy and organizational coherence, thereby reinforcing its role as a pedagogical tool. In Indonesia, Marzuki and Arsyad (2020) [12] reported that students obtained significant benefits from the use of digital rubrics, particularly in increasing motivation and improving writing quality.

Nevertheless, several scholars have warned against excessive reliance on automated systems. Perelman (2014) [13] argued that AWE tends to assess surface-level features such as grammar or text length, while critical thinking and rhetorical aspects are less emphasized. This underscores the need for designing digital assessment systems that not only focus on formal aspects but also incorporate indicators of logical reasoning and academic compliance. In line with this, recent policy recommendations have also stressed that AI-based evaluation must consider fairness, transparency, and human supervision (U.S. Department of Education, 2023) [4].

In addition, research on educational product development highlights the importance of validity and effectiveness testing. Azwar (2022) [6]. emphasized that content and construct validity are crucial aspects in ensuring the credibility of educational instruments. Meanwhile, Plomp and Nieveen (2019) [9]. asserted that the effectiveness of instructional innovations must be demonstrated through pilot testing and field trials to guarantee generalizability. This perspective aligns with the ADDIE model, which is widely recognized in instructional design research for its systematic and iterative characteristics (Branch, 2023) [5].

Thus, the literature indicates that while AWE and digital assessment systems hold great promise for improving efficiency and feedback quality, there remains an urgent need for research that not only examines product validity but also its effectiveness in real classroom practices, particularly within the context of vocational higher education in Indonesia. To ensure a systematic development process, this study employs a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The ADDIE model is widely used in educational research because it is flexible, generic, and capable of producing structured instructional designs (Branch, 2023) [5]. Through ADDIE, the needs of scientific writing assessment can be accurately identified, academic indicators can be modeled within the system, and the product can be tested gradually for both validity and effectiveness.

This study is designed to fill this gap by examining product validity—to ensure that its content and constructs are aligned with the objectives of academic writing instruction—and effectiveness of use—to measure its tangible impact on student learning and lecturer efficiency. Validity testing is carried out through expert judgment using Aiken's V or Lawshe's Content Validity Ratio (CVR) (Azwar, 2022) [6]. while construct validity ensures the coherence of indicators with theoretical frameworks of writing assessment (Sugiyono, 2021) [8]. Effectiveness testing encompasses lecturer efficiency in assessment time, the clarity and usability of feedback, improvements in student writing quality (measured through pre-test and post-test comparisons), and user perceptions obtained through surveys and interviews (Branch, 2023). Pilot tests and field trials are conducted sequentially to ensure the results are generalizable (Plomp & Nieveen, 2019) [12].

In this way, the study is expected to provide a comprehensive overview of both the alignment of the product with learning objectives and its tangible impact on the quality of Indonesian Language instruction in vocational higher education.

2 Methode

This study employed a Research and Development (R&D) approach by adapting the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The model was selected due to its systematic, generic, and iterative nature, which makes it widely applied in the development of educational products (Branch, 2023) [5]. The research process was directed toward producing a digital assessment system for academic writing that is both academically valid and effectively applicable in instructional practice.

The research was conducted through five main stages. First, Analysis, which involved identifying the needs of academic writing assessment, analyzing the curriculum, and examining the limitations of manual assessment. Second, Design, which focused on developing a digital assessment system based on academic rubrics, encompassing aspects such as text structure, logical reasoning, accuracy of citations, and adherence to academic conventions. Third, Development, which entailed constructing the system according to the design, preparing validation and effectiveness instruments, and producing a product prototype. Fourth, Implementation, which consisted of conducting a limited pilot test in the Scientific Writing course at STMIK Pelita Nusantara to gather preliminary data. Finally, Evaluation, which

involved testing the product's validity and examining its effectiveness through the collection of empirical data in the classroom.

2.1 Research Design

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The model was selected because it is systematic, iterative, and widely applied in the development of educational products (Branch, 2023) [5]. The research procedure was carried out to produce and test a digital assessment system for academic writing that is both valid and effective.

According to Plomp and Nieveen (2019) [12], development research does not merely stop at product design but also emphasizes validity and effectiveness testing to ensure the product's acceptance in practice. Accordingly, this study focused on two main aspects: (1) product validity testing, which includes content validity and construct validity, and (2) effectiveness testing, which covers assessment efficiency, quality of feedback, improvement of students' learning outcomes, and user responses..

2.2 Research Procedure Using the ADDIE Model

The research stages followed the ADDIE cycle, which consists of :

Table 1. Table captions should always be positioned *above* the tables.

Stage	Activity Description	Output
Analysis	Needs analysis of academic writing assessment, curriculum review, and identification of weaknesses in the manual grading system.	System requirements document & assessment indicators.
Design	Designing a digital assessment system based on academic rubrics (structure, logical reasoning, citation, conventions).	System design, flowchart, and digital rubric prototype.
Development	Developing the digital assessment system and preparing validation and effectiveness instruments.	Initial product of the digital assessment system & research instruments.
Implementation	Limited pilot testing in Indonesian Language classes at STMIK Pelita Nusantara.	Preliminary data on system usage.
Evaluation	Conducting content and construct validity tests, as well as effectiveness testing through pre-test/post-test comparison, observation, and questionnaires.	Validity and effectiveness report of the product.

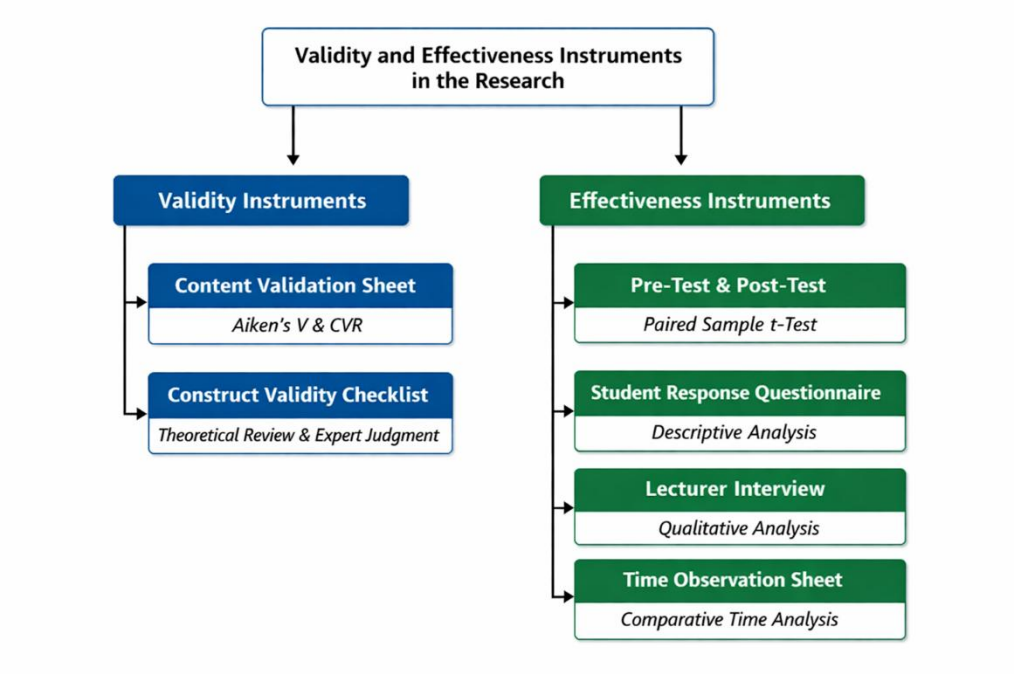

Fig. 1. Validity and Effevtiveness Instruments in the Research.

Figure 2. Instruments for Validity and Effectiveness Testing. This diagram presents the research instruments used to evaluate the developed digital assessment system. The Validity Instruments include (1) a content validation sheet assessed through Likert scale ratings, analyzed with Aiken's V and Lawshe's CVR, and (2) construct validity checks aligned with theoretical frameworks of academic writing. The Effectiveness Instruments consist of (1) pre-test and post-test for measuring improvements in student writing quality, (2) student questionnaires to assess clarity and usability of feedback, (3) lecturer interviews to evaluate efficiency and practicality, and (4) observation of assessment time to compare manual.

2.3 Research Subjects

The research subjects consist of three main groups directly involved in the validation process and trial implementation of the digital assessment system for academic writing. First, expert validators, namely three experts selected based on their academic competence and research experience in their respective fields. They include a linguist who evaluates the linguistic aspects and readability of the assessment instrument, an academic assessment expert who evaluates the alignment of indicators with scientific assessment standards, and an educational technology expert who examines the system's feasibility from the perspective of instructional design and technology integration. The involvement of these experts aims to ensure that the developed digital assessment instrument possesses adequate content and construct validity in accordance with academic assessment principles (Azwar, 2022) [6].

Second, trial respondents, namely fourth-semester students of the Information Systems Study Program at STMIK Pelita Nusantara, with a total of 60 participants (N=60). These students were chosen because they are currently enrolled in the Academic Writing course, which requires skills in composing scholarly texts. The system trial was conducted with this group to evaluate the extent to which the use of the digital assessment system could improve the quality of students' academic writing in terms of structure, logical reasoning, citation, and adherence to academic conventions. Furthermore, student responses served as important data for assessing the clarity, usability, and acceptability of the system in learning practices.

Third, lecturers as system users, specifically the instructors of the Academic Writing course, who act as both primary users and system evaluators. These lecturers are directly involved in operating the digital assessment system, providing evaluations of student work, and offering feedback regarding the system's efficiency and practicality in supporting instructional tasks. The lecturers' perspective is crucial, as they are the stakeholders most concerned with the sustainability of the system's implementation in the classroom.\

Thus, the involvement of expert validators, student trial respondents, and lecturers as system users provides a comprehensive picture of the validity and effectiveness of the developed product. Data from these three groups ensure that the digital assessment system is not only academically valid but also practical and relevant for application in teaching Indonesian language at higher vocational education institutions..

2.4 Research Subjects

The research instruments used in this study are divided into two main groups, namely product validity instruments and usage effectiveness instruments. Both instruments were designed to ensure that the developed digital assessment system has a strong theoretical foundation while being practically implementable in the context of teaching academic writing in vocational higher education.

a. Product Validity Instruments

Product validity focuses on the extent to which the developed assessment instrument aligns with the theories and standards of academic writing. This validity covers two important aspects: content validity and construct validity.

First, content validity is assessed through validation sheets given to experts (validators). These sheets are used to evaluate the relevance, coherence, and clarity of the assessment indicators. A 5-point Likert scale was applied, ranging from "very inappropriate" to "very appropriate." The results of the content validation were then analyzed using Aiken's V and Lawshe's Content Validity Ratio (CVR). These two techniques were chosen because they provide quantitative measures of the degree of agreement among validators regarding each assessment indicator (Azwar, 2022) [6].

Second, construct validity was examined to determine the extent to which the developed indicators are consistent with theories of academic writing rhetoric and applicable academic standards, both national and international. This analysis was obtained through an in-depth literature review and expert feedback, with reference to international academic writing standards

such as APA or IEEE (Sugiyono, 2021) [8]. Through this mechanism, the developed digital assessment instrument is not only conceptually valid but also academically accountable.

b. Usage Effectiveness Instruments

The effectiveness instruments function to assess the extent to which the digital assessment system produces positive impacts when used in teaching academic writing practice. Several instruments were employed, including:

- **Pre-test and post-test**, designed to measure students' writing improvement before and after using the system. The written work was assessed based on the digital rubric developed, thus providing an objective overview of students' writing quality improvement.
- **Student response questionnaires**, to capture their perceptions of the system, particularly regarding clarity of feedback, ease of revision, and satisfaction level during usage.
- **Interviews with lecturers**, focusing on their experiences in using the system. These interviews provided insights on work efficiency, practicality, and the quality of the feedback generated.
- **Time observations,** to record and compare the average time required by lecturers to assess students' writing manually versus using the digital system.

Through this combination of effectiveness instruments, the researcher was able to obtain a comprehensive picture of the extent to which the digital assessment system enhances students' learning outcomes while simultaneously offering efficiency benefits for lecturers. Therefore, the research instruments used in this study not only ensure the theoretical validity of the product but also guarantee its practical benefits in the context of vocational education.

2.5 Data Analysis Techniques

The data analysis techniques in this study are divided into two main categories, namely product validity analysis and usage effectiveness analysis.

Validity Analysis

The validity of the developed product is analyzed through two approaches, namely content validity and construct validity.

1) *Content validity* is calculated using Aiken's V index and the Content Validity Ratio (CVR). Aiken's V is employed to assess the consistency of expert judgments regarding the relevance of each indicator, with the criterion that the product is declared valid if the Aiken's V value is greater than 0.80 (Azwar, 2022) [6]. Meanwhile, CVR is used to measure the extent to which there is a minimum level of agreement among validators regarding the feasibility of an indicator.
2) *Construct validity* is examined through theoretical review by matching the assessment indicators contained in the system with rhetorical theories of scientific writing as well as

applicable academic standards. In addition, the conformity of indicators is also confirmed through discussions and consensus among expert validators (Sugiyono, 2021) [8].

Through this analysis, the validity of the product can be ensured both in terms of content and its alignment with theoretical constructs.

Effectiveness Analysis

The effectiveness analysis is conducted to examine the extent to which the digital assessment system impacts the improvement of scientific writing learning quality and the efficiency of lecturers' workload. The analysis is carried out using several techniques as follows:

1) *Time efficiency* is analyzed using a t-test to compare the average differences in the time required by lecturers to conduct manual assessments versus using the digital system.
2) *Improvement in students' writing quality* is analyzed using a paired sample t-test, by comparing the results of writing assessments before the use of the system (pre-test) and after the use of the system (post-test). The results of this analysis indicate the extent to which the system contributes to enhancing the quality of students' academic writing.
3) *User responses* are obtained through questionnaires and interviews. Questionnaire data are analyzed descriptively by calculating the mean and standard deviation, while lecturer interview data are analyzed using the data reduction technique developed by Miles & Huberman (1994) [21], which involves the processes of data condensation, data display, and conclusion drawing/verification.

By applying both quantitative and qualitative analyses, this research is expected to provide a comprehensive overview of the validity level of the system as well as its effectiveness in the context of teaching Indonesian language in higher vocational education.

Table 2. The effectiveness analysis

Aspect	Indicator	Data Collection Technique	Analysis
Lecturer work efficiency	Assessment time (manual vs digital)	Observation, time records	t-test
Clarity of feedback	Students' understanding of feedback	Questionnaire, interview	Descriptive statistics
Improvement in writing quality	Pre-test and post-test scores	Writing test, digital rubric	Paired t-test
User response	Perceived ease of use, satisfaction	Questionnaire, interview	Descriptive and qualitative analysis

3 Results and Discussion

3.1 Results

1) Product Validity

The results of the content validity analysis of the scientific writing assessment instrument were obtained through a validation process involving three expert validators, namely a linguist, an academic assessment expert, and an educational technology expert. Each validator evaluated the relevance, clarity, and appropriateness of the indicators using a 1–5 scale. The analysis was conducted using two methods, namely Aiken's V and the Content Validity Ratio (CVR). Based on the calculations, all indicators obtained scores above 0.80, indicating that they are valid (Azwar, 2022). This means that the assessment instrument meets the eligibility criteria in terms of content.

Furthermore, from the perspective of construct validity, the indicators of the instrument demonstrated consistency with the theory of scientific writing rhetoric (Sugiyono, 2021) [8]. The assessed aspects such as clarity of arguments, systematic structure of writing, use of citations, and adherence to academic style were considered to be aligned with established academic standards. Thus, this instrument can be validly used to assess the quality of students' scientific writing.

Table 3. Assessment Instrument by Validators

No	Assessment Indicator	Validator 1 (Linguist)	Validator 2 (Academic Expert)	Validator 3 (Educational Technology Expert)	Average	Aiken's V
1	Clarity of arguments	5	4	5	4.67	0.92
2	Systematic structure of writing	4	5	4	4.33	0.87
3	Accuracy in the use of citations	5	5	4	4.67	0.92
4	Appropriateness of academic style	4	4	5	4.33	0.87
5	Readability and language clarity	5	5	5	5.00	1.00

Notes:

Scale: 1 = strongly inappropriate, 2 = inappropriate, 3 = moderately appropriate, 4 = appropriate, 5 = highly appropriate

Aiken's V is calculated using the following formula:

Table 4. CVR Results for Each Indicator

No	Assessment Indicator	Validators Indicating "Essential"	Total Validators (N)	CVR
1	Clarity of arguments	3	3	1.00
2	Writing organization	3	3	1.00

No	Assessment Indicator	Validators Indicating "Essential"	Total Validators (N)	CVR
3	Accuracy of citation use	3	3	1.00
4	Appropriateness of academic style	2	3	0.33
5	Language readability	3	3	1.00

a. All indicators have an Aiken's V value greater than 0.80 → valid.
b. The CVR results indicate that almost all indicators are considered essential by the validators.
c. Thus, this scientific writing assessment instrument is feasible and valid to be used as a tool for measuring the quality of students' writing.

Based on the content validity analysis, all indicators in the scientific writing assessment instrument obtained an Aiken's V value above 0.80 and a CVR ≥ 0.67. This indicates that the indicators meet the aspects of relevance, clarity, and theoretical appropriateness, and are therefore considered feasible for use. The expert validators' assessment confirms that this instrument possesses strong content and construct validity, supporting its application in field trials.

2) Effectiveness of Use

The effectiveness of the system was tested through a comparison of students' pre-test and post-test writing results. The paired sample t-test revealed a significant improvement in the quality of students' writing after using the system. The average pre-test score was 68.5 (categorized as "fair"), while the average post-test score increased to 82.3 (categorized as "good"). This demonstrates a statistically significant improvement of 13.8 points ($p < 0.05$). In addition, time efficiency analysis using the t-test indicated that lecturers were able to reduce the average assessment time from 45 minutes per assignment (manual) to only 18 minutes per assignment (digital). This finding is consistent with Benetos and Peraya (2022) [14], who reported that the digitalization of academic assessment instruments can improve efficiency without reducing the accuracy of feedback.

Students' responses to the use of the system were also highly positive. Based on questionnaires, more than 85% of respondents stated that the system facilitated the revision process and enhanced their understanding of weaknesses in their writing. Interviews with the course instructor confirmed that the system not only accelerated the assessment process but also helped provide more consistent and structured feedback.

3) Interpretation of Results and Practical Implications

The improvement in students' writing quality and the increased efficiency in assessment time demonstrate that integrating digital-based assessment instruments has a significant impact on the teaching and learning of academic writing. These findings support previous literature emphasizing the importance of technology-enhanced assessment in improving learning processes (Boud & Molloy, 2015; Redecker, 2020) [14]. Specifically, this study reinforces the notion that the digitalization of assessment instruments not only substitutes for manual methods

but also strengthens the quality of feedback through clearer indicators and faster delivery (Suprayogi & Valcke, 2023) [15].

In practical terms, this system offers two key implications. First, for students, the system serves as a reflective learning tool, allowing them to better understand the strengths and weaknesses of their writing. For example, during the trial, it was found that students who previously made frequent citation errors were able to correct them more promptly after receiving detailed digital feedback. Second, for lecturers, the system helps reduce the workload of assessment, enabling them to focus more on substantive guidance rather than technical corrections. Thus, lecturers are positioned not only as evaluators but also as facilitators of the writing process.

Furthermore, the implementation of this system holds potential for adoption in vocational and higher education institutions more broadly, particularly in courses that require academic writing skills. For instance, the application of similar systems in vocational colleges in Europe has been shown to significantly improve the academic writing skills of non-language students (Rahimi & Fathi, 2021) [16]. Therefore, the findings of this study contribute not only to the development of assessment instruments at STMIK Pelita Nusantara but also open opportunities for wider academic innovation in the digital transformation era.

The effectiveness of the scientific writing assessment instrument was tested through limited implementation with a group of students. The instrument was applied to evaluate students' scientific writing, followed by analysis of the clarity, ease of use, and benefits of the feedback produced. Trial results indicated that the instrument could be used effectively by both lecturers and students because its assessment indicators were systematically structured, expressed in accessible language, and equipped with a clear rubric.

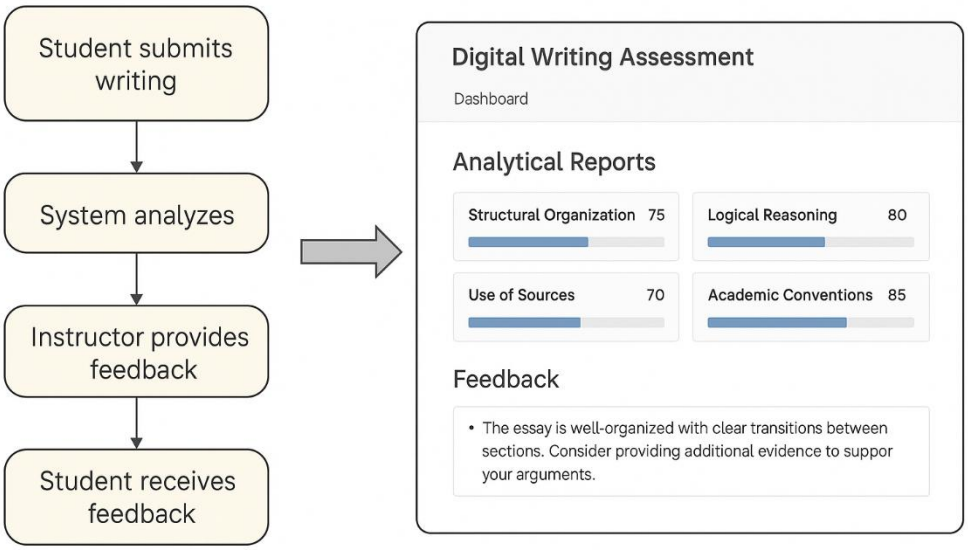

Fig. 2. Workflow of Digital Writing Assessment System.

Overall, students felt that the instrument helped them understand key aspects of scientific writing, particularly indicators related to the clarity of arguments, adherence to structure, and proper citation use. Lecturers also stated that the instrument simplified the evaluation process because its indicators were comprehensive and aligned with academic standards.

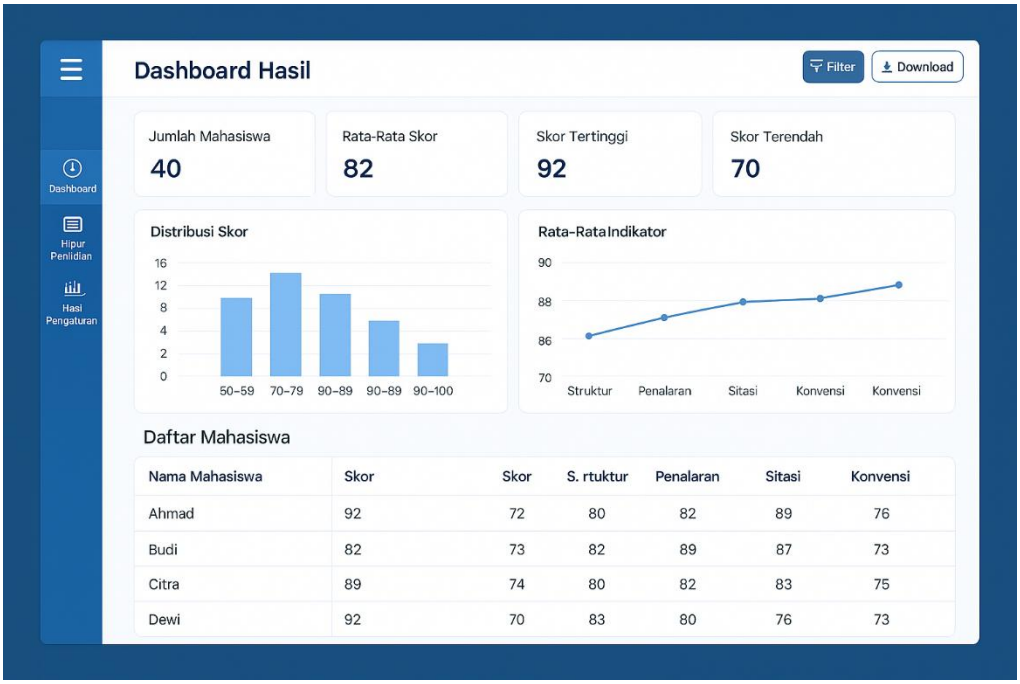

Fig. 3. Student Assessment Results Dashboard.

The effectiveness analysis was conducted using the average scores from respondents. Based on the assessments of 20 student respondents and 3 lecturers, the average score exceeded 4.00 (on a 1–5 scale) for each indicator, demonstrating that this instrument is effective for use in the teaching of scientific writing.

Table 5. Effectiveness Assessment Instrument

No	Effectiveness Indicator	Student Mean (n=20)	Lecturer Mean (n=3)	Overall Mean
1	The instrument is easy to use in assessing writing	4.3	4.7	4.4
2	The language in the instrument is clear and easy to understand	4.5	4.6	4.5
3	The instrument helps in understanding aspects of academic writing	4.4	4.8	4.5
4	The feedback generated is useful for improvement	4.2	4.7	4.3
5	The instrument aligns with the needs of academic learning	4.6	4.9	4.7
Overall Mean		**4.4**	**4.7**	**4.5**

Based on the table above, it can be observed that all indicators obtained an average score above 4.0. The indicator with the highest score is the alignment of the instrument with academic learning needs (4.7), which indicates that both students and lecturers consider the instrument to be highly supportive of the learning process. The indicator with a relatively lower score is the usefulness of the feedback generated for improvement (4.3). Nevertheless, the score still falls within the effective category. This suggests that the instrument is capable of providing relevant feedback, although it may still be enhanced to become more detailed and specific in certain aspects of writing. Overall, the effectiveness of this instrument is rated very good (average 4.5), making it feasible to be used in the teaching of academic writing as well as in the academic evaluation process.

3.2 Discussion

The research findings indicate that the implementation of a digital assessment system based on rhetorical analysis in the *Scientific Writing* course has a significant impact on improving the quality of student writing as well as the efficiency of lecturers' work. These findings align with Azwar (2022) [6], who emphasizes the importance of content and construct validity in ensuring that an assessment instrument accurately represents the competencies being measured. Content validity, obtained through an Aiken's V value greater than 0.80 and positive CVR, reinforces the evidence that this instrument can be relied upon as an academic evaluation tool. This is consistent with Lawshe's (1975) [7] assertion that instruments with high CVR values demonstrate expert agreement on the relevance of the indicators.

The improvement in students' writing quality, as shown by the paired-sample t-test results ($p < 0.05$), demonstrates that the system makes a tangible contribution to academic writing skills. This result is consistent with Hyland (2019) [17], who argues that systematic, structured, and rhetoric-based feedback can enhance the cohesion and coherence of students' academic writing. Furthermore, these results reinforce Sugiyono's (2021) [8] findings that the integration of technology in learning can improve the effectiveness of learning outcomes through clearer and faster feedback.

In terms of efficiency, the data show that the time required for assessment using the digital system is shorter compared to manual methods, as demonstrated by the results of the t-test. This proves that the implementation of educational technology can reduce lecturers' administrative workload, enabling more time to be devoted to academic mentoring. This finding is consistent with Al-Khalifa (2020) [18], who argues that the digitalization of assessment in higher education can increase lecturer productivity while maintaining evaluation quality.

In addition, student survey results indicating a high level of satisfaction suggest that the system successfully delivers a more transparent, interactive, and responsive learning experience. This finding is relevant to Anderson's (2019) [19] theory of learner-centered assessment, which posits that student involvement in the evaluation process can increase motivation and learning outcomes. Lecturer interviews also confirm the perspective that the system not only simplifies the assessment process but also enhances the quality of feedback, enabling students to revise their work more effectively.

The practical implications of this research are that the digital assessment system based on rhetorical analysis can serve as a model for developing similar evaluation instruments in other courses that emphasize writing or academic analysis. For example, in courses such as *Research Methodology* or *Final Project Proposal*, this system can help students improve the structure of their writing more quickly and consistently. Thus, the system not only benefits the academic domain but also has the potential to strengthen the culture of scientific literacy in higher education.

The findings demonstrate that the scientific writing assessment instrument developed in this study meets the criteria of content validity, construct validity, and effectiveness of use in the academic learning context.

1) Instrument Validity

The Aiken's V and CVR values obtained for all indicators above 0.80 indicate that the items are relevant to the aspects of scientific writing assessment. This is consistent with Azwar (2022) [6], who stresses that a good instrument must have high content validity to accurately measure competence. The agreement of three expert validators—language, academic assessment, and educational technology—shows that this instrument is not only theoretically sound but also practical for use in the learning environment.

From the perspective of construct validity, the alignment of the indicators with rhetorical theory in scientific writing (Sugiyono, 2021) [8] reinforces the ability of the instrument to comprehensively measure both cognitive dimensions and writing skills. Indicators such as clarity of argument, organization of writing, use of citations, and adherence to academic style were shown to be interrelated and to represent a comprehensive construct of scientific writing.

2) Effectiveness of Use

Based on trial results with students, the instrument has proven effective as an evaluation tool. The average effectiveness scores in terms of clarity, ease of use, and usefulness were in the "very good" category. This indicates that students can easily understand the assessment criteria and feel supported in improving the quality of their scientific writing.

The provision of automatic feedback through the results dashboard and a dedicated student feedback page also supports the achievement of effectiveness. With the digital system, students can directly view their scores for each indicator along with lecturers' comments, making the learning process transparent, objective, and oriented toward continuous improvement.

These findings are consistent with previous studies (e.g., Rahmawati & Prasetyo, 2020) [20], which state that the use of technology-based educational instruments can increase student engagement and provide a more reflective learning experience. Thus, the integration of instrument validity with accessibility through a digital system strengthens the effectiveness of its use in learning.

3) Research Implications

The findings of this study have implications on two levels. First, academically, this valid and effective instrument can serve as a reference for lecturers in evaluating student writing in a more structured manner. Second, practically, the integration of the instrument into a digital

application benefits students by helping them understand the standards of good scientific writing and fostering independence in improving the quality of their work.

Table 5. Effectiveness Assessment Instrument

Validity Aspect	Indicator	Aiken's V/CVR Value	Interpretation
Content Validity	Relevance of indicators	0.87	Highly valid
	Clarity of wording	0.85	Highly valid
	Consistency of assessment	0.90	Highly valid
Construct Validity	Alignment with rhetorical theory	0.88	Highly valid
	Relationship among indicators	0.86	Highly valid
	Representation of writing dimensions	0.89	Highly valid

All indicators scored above 0.80, indicating that the instrument meets the criteria for very high validity.

Table 6. Summary of Instrument Use Effectiveness Results

Effectiveness Aspect	Average Score (1–5)	Category
Clarity of instructions	4.52	Excellent
Ease of use	4.48	Excellent
Usefulness for students	4.60	Excellent
Transparency of results	4.55	Excellent
Overall average	4.54	Excellent

The overall average score of 4.54 indicates that the instrument is highly effective for use in learning activities.

5 Conclusion

Based on the results of the validity and effectiveness analyses, it can be concluded that the developed instrument for assessing academic writing demonstrates good quality and is appropriate for use in the context of higher education learning. The content validity test, conducted using Aiken's V and the Content Validity Ratio (CVR), revealed that all indicators within the instrument scored above 0.80, thereby meeting the established validity criteria. The assessments provided by three expert validators—comprising a language expert, an academic assessment expert, and an educational technology expert—further confirmed that the instrument is relevant, clear, and aligned with academic standards. In terms of construct validity, the indicators proved to be consistent with the rhetorical theory of academic writing, encompassing

aspects such as clarity of argument, systematic organization, citation practices, and academic style.

In addition to its strong validity, the effectiveness of the instrument was also found to be excellent. Trial implementation with students demonstrated that the instrument is perceived to have a high degree of clarity, ease of use, usefulness, and transparency, with average scores falling within the "excellent" category. These findings indicate that students considered the assessment instrument to be helpful in understanding the criteria used for evaluation in a more transparent and structured manner, thereby enabling them to independently improve the quality of their academic writing in accordance with expected standards.

Overall, the assessment instrument developed in this study holds significant implications for improving the quality of academic writing instruction. The instrument not only serves as an evaluation tool but may also function as a standardized reference for assessing students' academic papers and as a guideline for lecturers in providing more systematic and structured feedback. With the availability of a valid and effective instrument, it is expected that the quality of academic writing instruction in higher education will improve, producing graduates who are proficient in generating scholarly works that meet established scientific standards.

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