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HOW STUDENTS UNDERSTAND AND LEARN IMRAD STRUCTURE: EVIDENCE FROM A SCIENTIFIC WRITING WORKSHOP

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This study aims to examine how undergraduate students understand and improve their knowledge of IMRAD-based scientific writing following a basic scientific writing workshop. The research adopts a descriptive quantitative approach using a pre-test and post-test design involving students from the Management Study Program, Faculty of Economics and Business, Universitas Teuku Umar (n=41), with 28 participants completing the pre-test and 26 completing the post-test. Data were analyzed descriptively to compare patterns of understanding before and after the workshop. The findings indicate that students initially demonstrated a basic understanding of IMRAD components, but showed limitations in higher-order conceptual aspects, particularly in distinguishing between Results and Discussion and understanding methodological rigor, as reflected by only 78.6% accuracy in identifying the Results section. Post-test results reveal a substantial improvement, with most students able to correctly identify structural errors, evaluate methodological transparency, and recognize issues such as overclaiming, redundancy, and poor logical flow, indicating a shift toward more analytical and critical thinking. However, the study is limited by the respondent gap between pre-test and post-test, which restricts individual-level comparison. Practically, the findings suggest that workshop-based learning is effective in strengthening academic writing skills, particularly when emphasizing conceptual clarity and applied analysis. Socially, improving students' scientific writing competence may contribute to fostering a culture of scientific literacy and research engagement in higher education. This study provides empirical evidence on the progression of students' understanding of IMRAD, highlighting the role of structured workshops in transforming misconceptions into analytical competence and offering insights for designing effective academic writing interventions.

Keywords: IMRAD Structure, Scientific Writing, Academic Literacy, Workshop

Introduction

Universitas Teuku Umar (UTU) has positioned itself as a Source of Inspiration, emphasizing the strengthening of education, research, and scientific publication as strategic pillars for achieving academic competitiveness at regional, national, and international levels. This vision is not merely normative but appears to function as an epistemic framework guiding institutional transformation toward research-driven excellence. Philosophically, this orientation is reflected in the principle “Sowing Knowledge, Harvesting Prosperity,” which aligns with the legacy of Teuku Umar as a symbol of societal advancement through education and intellectual empowerment.

However, despite this strong institutional vision, empirical conditions at the Management Study Program, Faculty of Economics and Business, UTU, suggest a notable gap between strategic aspirations and academic reality. Institutional performance indicators appear to have declined, as reflected in the decrease of Key Performance Indicators (IKU) by 5.12 points and the relatively low achievement of IKU 2 (1.57%), which may indicate limited student engagement in scientific forums and academic publication activities. Furthermore, students’ interest in scientific writing remains considerably low, estimated at approximately 0.1%, while most student achievements tend to be concentrated in non-academic domains such as entrepreneurship programs, arts, and sports. This imbalance potentially reflects a weak culture of academic writing and limited exposure to structured scientific communication.

Several underlying factors may contribute to this condition. First, scientific writing practices among students are often characterized by excessive reliance on artificial intelligence tools without sufficient critical engagement (Black & Tomlinson, 2025; van Niekerk et al., 2025; Zhai et al., 2024), which may hinder the development of independent drafting and revision skills. Second, students appear to have limited ability to construct systematic and critical scientific arguments in accordance with academic conventions (Calma & Davies, 2026; Cui & Zhao, 2024). In this context, mastery of the IMRAD structure (Introduction, Methods, Results, and Discussion) is widely recognized as a fundamental standard for organizing scientific knowledge in a logical, transparent, and reproducible manner (Barroga & Matanguihan, 2021). However, it is possible that students’ understanding of this structure remains superficial, particularly in distinguishing between analytical components such as results and discussion (Eriksson, 2024; Ribeiro et al., 2018; Teodosiu, 2019).

In addition, institutional academic policies may unintentionally contribute to the delayed development of scientific writing skills (Eriksson, 2024; Misra, 2026). The requirement for publication is typically imposed only at the final stage of study, after the completion of undergraduate theses, which may limit early exposure to scientific writing practices. As a result, the development of a sustainable writing culture during earlier semesters appears to be constrained.

From a broader academic perspective, effective scientific writing involves not only structural competence but also higher-order skills such as synthesis and hedging. Synthesis requires the integration of multiple sources into coherent arguments, while hedging reflects the use of cautious and non-absolute language in presenting scientific

claims (Jumanto et al., 2024). These competencies are essential in producing credible and publishable research outputs. However, existing evidence suggests that novice writers often struggle to apply these principles effectively, which may affect the overall quality of their academic writing.

Given these challenges, an academic intervention in the form of a scientific writing workshop may serve as a potential strategy to enhance students' understanding of IMRAD-based writing and improve their ability to construct structured and critical scientific arguments (Ahmed & Afzal, 2020; Batmanabane, 2018; Özkan Çelik & Al, 2024; Yang et al., 2025). Such interventions have been suggested to facilitate conceptual learning, particularly when combined with practice-based approaches such as mini research and guided drafting activities.

Therefore, this study aims to examine how students understand and improve their knowledge of IMRAD-based scientific writing following a basic scientific writing workshop. Specifically, this study seeks to explore students' initial understanding of IMRAD structure, changes in their conceptual comprehension after the intervention, and key areas of difficulty and misconception in scientific writing. It is expected that the findings may provide insights into the effectiveness of workshop-based academic interventions in fostering scientific literacy and writing culture among undergraduate students.

Method

This study employed a quantitative descriptive approach with a pre-experimental one-group pre-test–post-test design to examine students' understanding of the IMRAD structure in a Basic Scientific Writing Workshop. The instrument was developed using Google Forms by the research team and consisted of two main sections, namely a pre-test administered prior to the workshop and a post-test administered after the workshop activities were completed. The pre-test included structured multiple-choice and short-answer questions assessing basic knowledge of IMRAD components including Introduction, Methods, Results, and Discussion, while the post-test consisted of case-based analytical questions designed to evaluate higher-order understanding such as the ability to identify structural errors, methodological weaknesses, and common issues in scientific writing. Participation was voluntary and informed consent was obtained at the beginning of the form, allowing participants to either continue or exit the survey. The study population comprised undergraduate students of the Management Study Program, Faculty of Economics and Business, Universitas Teuku Umar, who attended the workshop ($n = 41$). Data were analyzed using descriptive statistics to summarize response patterns and levels of understanding related to scientific writing based on the IMRAD structure, while comparative analysis was conducted by coding responses into correct and incorrect categories to identify changes in comprehension. In addition, qualitative responses were examined to identify common misconceptions and reasoning patterns, particularly in distinguishing between IMRAD sections, methodological clarity, and logical flow in scientific writing.

Result

Participant Characteristics

Table 1 presents the descriptive characteristics of the study participants. The participants of this study consisted of undergraduate students from the Management Study Program, Faculty of Economics and Business, Universitas Teuku Umar, who attended the workshop (n = 41).

Of the total participants, 28 students completed the pre-test and 26 completed the post-test, indicating a variation in response rates across the two stages of data collection. This difference suggests a participation gap, which may be considered as a methodological limitation, particularly in assessing individual-level changes between pre-test and post-test responses.

All participants were undergraduate students with relatively similar academic backgrounds, as the workshop specifically targeted early-stage learners who were newly introduced to scientific writing and the IMRAD structure. Therefore, the sample can be considered homogeneous in terms of educational level and academic exposure.

Tabel 1. Characteristics of Study Participants (n = 41)

Characteristics	Category	Number (n)	Percentage (%)
Participant type	Undergraduate students	41	100
	Completed	28	68.3
Participation in pre-test	Not Completed	13	31.7
	Completed	26	63.4
Participation in post-test	Not Completed	15	36.6

Initial Understanding of IMRAD Structure

Table 2 presents the distribution of correct and incorrect responses in the pre-test related to students' initial understanding of the IMRAD structure. Overall, the findings suggest that most participants demonstrated a foundational level of knowledge regarding scientific writing conventions. Nearly all respondents were able to correctly identify the meaning of IMRAD and explain the primary function of the Introduction section as providing background, objectives, and research rationale. Similarly, the majority correctly recognized the Methods section as the part that explains how a study is conducted to ensure reproducibility.

However, a closer examination of response patterns reveals notable inconsistencies in more analytical components. Errors were most frequently observed in identifying the correct content of the Results section, where several respondents included interpretative statements or background information instead of focusing strictly on research findings. Likewise, a number of students showed confusion in distinguishing

the role of the Discussion section, with some incorrectly associating it with methodological explanation or data presentation rather than interpretation and comparison with previous studies.

In addition, minor inaccuracies were identified in questions related to abstract functions, keywords, and common methodological errors. While most participants understood that abstracts provide a concise summary and keywords support indexing and discoverability, a small proportion of responses indicated misconceptions, such as equating abstracts with full data presentation or misplacing results within the Methods section.

These findings suggest that although students possessed basic structural awareness of IMRAD, their deeper conceptual understanding, particularly in differentiating between empirical findings and interpretative analysis, remained limited. This pattern may indicate that students tend to memorize structural definitions without fully internalizing the epistemic function of each section in scientific argumentation.

Table 2. Pre-test Results on Initial Understanding of IMRAD Structure (n = 28)

Component Assessed	Correct n (%)	Incorrect n (%)
Definition of IMRAD	28 (100.0)	0 (0.0)
Function of Introduction	27 (96.4)	1 (3.6)
Identification of Methods	26 (92.9)	2 (7.1)
Content of Results	22 (78.6)	6 (21.4)
Function of Discussion	23 (82.1)	5 (17.9)
Characteristics of Title	27 (96.4)	1 (3.6)
Function of Abstract	25 (89.3)	3 (10.7)
Function of Keywords	25 (89.3)	3 (10.7)
Common Errors in Methods	24 (85.7)	4 (14.3)
Logical Flow Concept	26 (92.9)	2 (7.1)

The overall pattern indicates that surface-level recognition of IMRAD components was relatively high, while higher-order understanding involving differentiation, interpretation, and application remained an area of difficulty. This suggests that instructional interventions should place greater emphasis on conceptual clarity and critical reasoning rather than solely on structural identification.

Improvement in Understanding After the Workshop

Table 3 presents the post-test results reflecting students' understanding of scientific writing after participating in the workshop. Overall, the findings indicate a substantial improvement in students' conceptual and analytical comprehension of the IMRAD structure and academic writing principles. Almost all participants were able to correctly identify structural inconsistencies, such as improper sequencing of IMRAD sections, recognizing that deviations from the standard logical order may reduce coherence and weaken the scientific integrity of an article.

Furthermore, participants demonstrated a clear understanding of the importance of a well-developed Introduction, correctly identifying that the absence of background and

research gap may reduce the urgency and contextual relevance of a study. Similarly, nearly all respondents recognized that insufficient methodological detail limits reproducibility, indicating an increased awareness of transparency as a core principle in scientific research.

A notable improvement was also observed in students' ability to distinguish between Results and Discussion sections. Most participants correctly identified the error of placing interpretative statements within the Results section, reflecting a more refined understanding of the separation between empirical findings and analytical interpretation. In addition, students were able to identify common weaknesses in academic writing, including incomplete abstracts, lack of logical flow, redundancy in data presentation, and the use of outdated or insufficient references.

Importantly, participants showed strong awareness of critical academic issues such as overclaiming, recognizing that unsupported absolute claims without adequate comparison to existing literature weaken the credibility of research. They also demonstrated the ability to evaluate the implications of poor writing quality, with most respondents acknowledging that unclear structure and weak logical flow may lead to manuscript rejection despite having a strong methodological foundation.

These findings suggest that the workshop contributed to a shift from basic recognition toward higher-order thinking skills, where students not only understand the structure of scientific writing but are also able to critically evaluate its quality. This progression may indicate that experiential and case-based learning approaches are effective in strengthening analytical competence in academic writing.

Table 3. Post-test Results on Students' Analytical Understanding of Scientific Writing (n = 26)

Component Assessed	Correct n (%)	Incorrect n (%)
Identification of IMRAD structural order	25 (96.2)	1 (3.8)
Understanding of Introduction completeness	26 (100.0)	0 (0.0)
Recognition of methodological transparency	26 (100.0)	0 (0.0)
Distinction between Results and Discussion	25 (96.2)	1 (3.8)
Evaluation of abstract completeness	25 (96.2)	1 (3.8)
Logical flow and coherence	26 (100.0)	0 (0.0)
Identification of overclaiming	25 (96.2)	1 (3.8)
Relevance and recency of references	24 (92.3)	2 (7.7)
Recognition of data redundancy	26 (100.0)	0 (0.0)
Impact of writing quality on publication	25 (96.2)	1 (3.8)

Overall, the post-test results indicate that students developed a more critical and evaluative perspective toward scientific writing, particularly in identifying errors, assessing methodological rigor, and understanding the importance of clarity and logical structure in academic publications.

Students' Areas of Difficulty

The analysis of pre-test responses indicates that the most challenging aspects for students were distinguishing between the Results and Discussion sections and understanding methodological rigor. As shown in Table 2, a considerable proportion of respondents incorrectly identified the content of the Results section by including interpretative statements, suggesting confusion between presenting findings and explaining their meaning. Similarly, a number of students demonstrated partial misunderstanding of the Methods section, particularly regarding the level of detail required to ensure reproducibility.

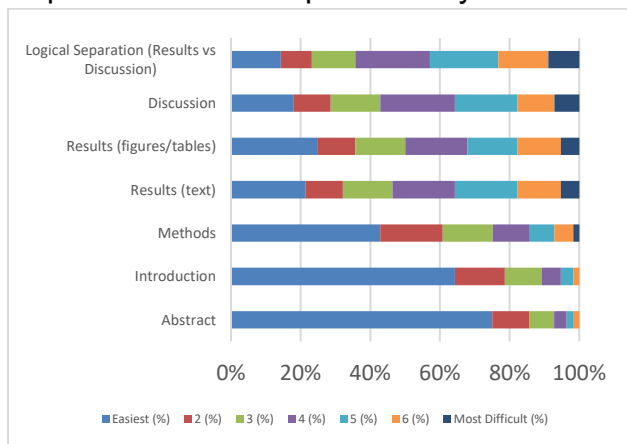


Figure 1. Perceived Areas of Difficulty in Understanding IMRAD Components (Pre-test, n = 28)

The pre-test results on perceived areas of difficulty indicate a clear gradient in students' understanding of IMRAD components. As shown in Table 2, the Abstract (75.0%) and Introduction (64.3%) were perceived as the easiest sections by the majority of respondents, suggesting that students are relatively comfortable with general and descriptive components of scientific writing. In contrast, the level of perceived difficulty increases substantially for more technical and analytical sections. The Methods section shows a more distributed response pattern, with only 42.9% identifying it as easiest and a noticeable proportion rating it across moderate to higher difficulty levels, indicating partial understanding of methodological detail and reproducibility. The Results section, both in text (21.4% easiest) and figures or tables (25.0% easiest), exhibits a shift toward higher difficulty ratings, with many students selecting mid to upper scale categories, reflecting challenges in interpreting and presenting empirical findings. The Discussion section is perceived as even more difficult, with only 17.9% rating it as easiest and higher concentrations in the upper difficulty levels, suggesting limited ability in analytical interpretation. The greatest challenge is observed in the logical separation between Results and Discussion, where only 14.3% rated it as easiest and a significant proportion placed it in higher difficulty categories, including 8.9% identifying it as the most difficult aspect. These findings indicate that while students can recognize basic structural elements, they encounter increasing difficulty when required to engage with more complex, higher-order aspects of scientific writing.

These difficulties reflect a broader pattern in which students tend to grasp structural definitions but struggle with higher-order conceptual distinctions. In particular, the separation between empirical reporting and analytical interpretation appears to be a critical challenge. This suggests that components requiring critical thinking and epistemic understanding, such as interpretation, justification, and methodological transparency, remain areas that may benefit from more intensive and practice-oriented instructional approaches.

Changes in Academic Perception

Post-test responses indicate a noticeable shift in students' academic perception of scientific writing. As reflected in Table 3, participants demonstrated increased awareness of the importance of methodological clarity, logical flow, and the completeness of key components such as abstracts. Students were able to recognize that insufficient methodological explanation limits reproducibility and that poor organization reduces the readability and credibility of an article.

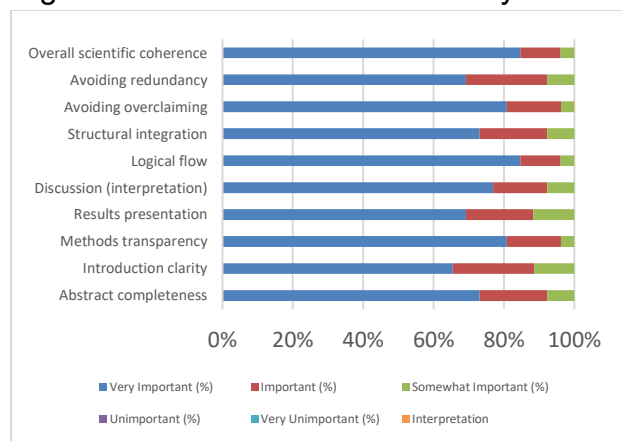


Figure 2. Perceived importance of scientific writing components after the workshop (post-test, n = 26)

The post-test results on perceived importance demonstrate a strong and consistent pattern in which the majority of students rated key components of scientific writing as highly important. As shown in Table 3, most respondents classified elements such as logical flow (84.6%), overall scientific coherence (84.6%), methods transparency (80.8%), and avoiding overclaiming (80.8%) as “very important,” indicating a heightened awareness of critical aspects that contribute to the quality and credibility of academic writing. Similarly, high proportions of students emphasized the importance of discussion and interpretation (76.9%), abstract completeness (73.1%), and structural integration (73.1%), reflecting an improved understanding of how different sections function collectively within a scientific article. Even components such as results presentation (69.2%), avoiding redundancy (69.2%), and introduction clarity (65.4%) were predominantly rated as “very important,” with the remaining responses largely falling into the “important” category. Notably, none of the components were perceived as unimportant, suggesting a uniformly positive shift in students' valuation of scientific writing elements. Overall, this distribution indicates that students not only

recognize individual components but also appreciate their relative importance in producing clear, coherent, and methodologically sound research outputs. Furthermore, responses suggest that students began to understand scientific writing as a structured and coherent argument rather than merely a collection of sections. They showed greater sensitivity to issues such as overclaiming, redundancy, and lack of integration between sections, indicating a more critical perspective toward academic texts. This shift may suggest that the workshop contributed to reshaping students' understanding of quality scientific writing, particularly in emphasizing the role of clarity, coherence, and methodological rigor as essential elements of credible academic work.

Comparative Analysis of Pre-test and Post-test

A comparative analysis of pre-test and post-test responses indicates a clear and consistent improvement in students' understanding of scientific writing. As reflected in Tables 2 and 3, students initially demonstrated a relatively strong ability to recognize basic IMRAD components, yet showed limitations in distinguishing between sections that require higher-order reasoning, particularly Results and Discussion, as well as in understanding methodological transparency. In contrast, post-test responses reveal that most participants were able to correctly identify structural errors, evaluate methodological weaknesses, and recognize common issues such as overclaiming, redundancy, and poor logical flow.

Table 4. Comparative analysis of students' understanding in pre-test and post-test

Analytical Aspect	Pre-test (n = 28)	Post-test (n = 26)	Pattern of Change	Interpretation
Understanding of IMRAD structure	Majority were able to recognize IMRAD components	Nearly all students demonstrated correct understanding	Stable → improved	Basic structural knowledge was already well established
Introduction section	Generally well understood	Remained consistently well understood	Stable	No substantial change observed
Methods (reproducibility)	Some students lacked understanding of methodological detail	Majority understood the importance of methodological transparency	Improved	Increased awareness of methodological rigor
Results vs Discussion	Many students confused results with interpretation	Majority correctly distinguished between sections	Significantly improved	Enhancement in higher-order conceptual understanding

Identification of structural errors	Limited ability to identify errors	Majority able to identify structural weaknesses	Significantly improved	Indicates development of analytical skills
Overclaiming	Rarely recognized as a problem	Widely recognized as a scientific writing issue	Significantly improved	Increased critical awareness
Redundancy in data presentation	Generally overlooked	Recognized as a writing weakness by most students	Improved	Better understanding of efficient data presentation
Logical flow	Understood at a basic level	Recognized as a key element of writing quality	Improved	Shift toward conceptual understanding
Critical thinking ability	Primarily surface-level recognition	Demonstrated ability to evaluate case-based scenarios	Significantly improved	Transition from surface to analytical thinking

Although the analysis remains descriptive due to the respondent gap between pre-test and post-test, the overall pattern suggests a shift from surface-level recognition toward more analytical and critical evaluation. Students not only improved in accuracy but also demonstrated a deeper understanding of the underlying principles of scientific writing, including clarity, coherence, and reproducibility.

This improvement may indicate that the workshop served as an effective academic learning activity in strengthening students' comprehension of IMRAD-based writing, particularly in fostering critical thinking and evaluative skills that are essential for producing high-quality scientific work.

Common Misconceptions in Scientific Writing

The pre-test findings reveal several recurring misconceptions in students' understanding of scientific writing, particularly in relation to the distinction between different IMRAD components. One of the most prominent issues is the tendency to mix empirical findings with interpretation. This is clearly reflected in Table 2, where 21.4% of respondents incorrectly identified the content of the Results section, often including interpretative or explanatory statements that should belong to the Discussion. This pattern indicates that a notable proportion of students had difficulty distinguishing between reporting data and interpreting its meaning, which is a fundamental principle in IMRAD-based writing.

In addition to this, misconceptions related to methodological transparency were also evident. Although the majority of students correctly recognized the Methods section in general terms 92.9% correct responses a smaller but meaningful proportion 7.1% still

showed misunderstanding regarding its function. More importantly, qualitative patterns in the responses suggest that some students perceived brief or vague methodological descriptions as sufficient. This indicates a limited awareness of reproducibility as a core standard in scientific research, where methods must be described in enough detail to allow replication.

Misconceptions were also observed in supporting components of scientific writing, although at a lower frequency. As shown in Table 2, 10.7% of respondents provided incorrect answers regarding the function of abstracts and keywords. Some students appeared to interpret abstracts as extended background descriptions rather than concise summaries of the entire study, while others did not fully understand the role of keywords in indexing and discoverability. Similarly, errors related to common methodological mistakes 14.3% incorrect suggest that not all students were able to identify inappropriate practices such as embedding results within the Methods section. Overall, these findings indicate that the initial challenges faced by students were not solely technical but also conceptual in nature. While surface-level recognition of IMRAD components was relatively high across most categories, deeper understanding involving logical flow, structural coherence, and the epistemological role of each section remained limited. In particular, difficulties in separating results from interpretation and in understanding methodological rigor highlight gaps in higher-order thinking. This suggests the need for instructional approaches that go beyond structural memorization and instead emphasize critical reasoning, conceptual clarity, and the underlying logic of scientific argumentation.

Conclusion

This study demonstrates that undergraduate students initially possessed a basic understanding of the IMRAD structure, particularly in recognizing its components and general functions, yet showed clear limitations in higher-order conceptual understanding, especially in distinguishing between Results and Discussion and in comprehending methodological rigor. This is reflected in the pre-test results, where only 78.6% of students correctly identified the content of the Results section, indicating gaps in separating empirical findings from interpretation. Following the workshop, students exhibited substantial improvement, as evidenced by their enhanced ability to identify structural inconsistencies, evaluate methodological transparency, and recognize common scientific writing issues such as overclaiming, redundancy, and weak logical flow, alongside stronger performance in case-based analytical tasks.

These findings suggest that students' initial difficulties are less related to lack of exposure and more to limited understanding of the epistemological roles within IMRAD, implying that structured, workshop-based learning that integrates conceptual explanation with applied analysis can effectively support the transition from surface-level recognition to deeper analytical competence. Practically, this highlights the importance of embedding IMRAD-focused training early in academic curricula with emphasis on critical evaluation, coherence, and reproducibility, while socially it

underscores the potential of such interventions to foster scientific literacy, strengthen academic writing culture, and enhance research engagement among undergraduate students. Overall, this study contributes original empirical insight into how students understand and learn IMRAD through a workshop context, demonstrating not only measurable improvement but also identifying specific areas of misconception, thereby offering valuable guidance for designing more effective academic writing interventions in higher education.

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