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Strengthening Research Writing Competencies in Physics and Biology Teachers: A Practical IMRAD-Based Guide

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Abstract

The objective of this community service activity is to enhance the research writing skills of physics and biology teachers through a practical guide based on the IMRAD (Introduction, Methods, Results, and Discussion) format. The method used was the Community-Based Participatory Research (CBPR) approach, which included four main stages: laying the foundation, research planning, information gathering and analysis, and acting on findings. The participants were 29 physics and biology teachers from senior high schools at UIN Raden Intan Lampung, who participated in the program from August to November 2024. The main finding was a significant improvement in participants' understanding of the IMRAD structure, with 98% reporting a strong grasp of scientific writing after the training. However, challenges remained in writing the research background in the Introduction and interpreting and communicating results in the Discussion, which require further attention. The IMRAD-based approach effectively enhances teachers' scientific writing skills, and additional mentoring is needed to address difficulties in specific sections. Future research could employ longitudinal studies to monitor instructors' publication progress, investigating the influence of peer collaboration, institutional support, and sustained mentoring on academic writing success.

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INTRODUCTION

Scientific writing plays a pivotal role in the professional development of educators by enhancing critical thinking, improving communication skills, and boosting self-confidence through the structured articulation of ideas, analytical problem-solving, and the validation of one's expertise in academic discourse. It is frequently a prerequisite for career advancement and essential to academic professionalism. Furthermore, the ability to write and publish scientific papers significantly contributes to teachers' professional competence. Research indicates that teachers who engage in scientific writing enhance their knowledge and improve their standing within the academic community. This

engagement allows them to contribute meaningfully to the scientific discourse in their fields, thereby advancing collective knowledge and fostering collaboration among peers (Fadila et al., 2024; Rahim et al., 2023; Velazco et al., 2023). Moreover, writing scientific papers compels teachers to engage deeply with their subject matter, enhancing their pedagogical skills and overall teaching effectiveness (Akbari, 2023). Despite the potential advantages, numerous educators encounter significant challenges in producing scholarly work.

Al-Qahtani et al., (2024) found that teachers' ability to produce scholarly work is quite limited due to factors such as insufficient knowledge of scientific writing and a lack of enthusiasm for writing scientific articles (Labobar et al., 2023). Gunawan et al., (2024) highlight several factors that contribute to these challenges, including a lack of experience and skills in scientific writing, limited access to scientific literature, and a dearth of local publication venues, all of which Smirnova et al., (2021) identify as significant barriers. Heng & Sol (2021) raise additional concerns, such as the scarcity of journals in educational settings, the absence of writing competitions established by educational authorities, and teachers' reluctance to participate in scientific writing activities. These challenges hinder teachers' professional development and restrict their ability to contribute to the broader educational community.

An interview with biology and physics teachers in Lampung revealed that they feel overwhelmed by the complexities of academic writing and lack confidence in their capacity to produce publishable research. They encounter substantial barriers to publishing their research, including insufficient training in scientific writing, restricted access to academic resources and mentorship, institutional obstacles that impede publication efforts, and low motivation to engage in scholarly writing. These challenges underscore the urgent necessity for a structured writing workshop that equips educators with the essential skills, guidance, and support required to enhance their research writing competencies and augment their contributions to academic discourse.

Considering the challenges that educators encounter in scientific writing, implementing a systematic approach such as the IMRAD technique is essential for enhancing research clarity and achieving success in publication. IMRAD, which stands for Introduction, Methods, Results, and Discussion, presents an organized framework for drafting research papers (Pilatti et al., 2023; Rahmat et al., 2023; Shankar & Arun, 2022). The IMRAD structure enhances clarity and accessibility in scientific writing, particularly for empirical research (Trinh et al., 2020). Studies by Das & Das (2019) and Shahid & Afzal (2017) further support that structured training in IMRAD-based writing significantly improves manuscript quality and publication success rates. The IMRAD format benefits authors by streamlining manuscript organization and improving research evaluation. Additionally, it plays a key role in scientific education, helping authors structure research effectively (Nisa et al., 2023) and aiding in abstract writing (Pangesti et al., 2023).

This community service activity aims to enhance writing competence by implementing the IMRAD (Introduction, Methods, Results, and Discussion) structure. By providing a clear framework for organizing ideas, this activity will equip participants with essential skills for producing well-structured and coherent academic writing.

METHODS

This community service activity was conducted offline at UIN Raden Intan Lampung and online via Zoom, with a cohort of 29 educators specializing in physics and biology at senior high schools, consisting of 16 biology teachers and 13 physics teachers with a minimum of two years of teaching experience. The initiative, from August 9 to November

30, 2024, involved a partnership between the Physics Education Program and the Physics Program at Universitas Pendidikan Indonesia (UPI), as well as the Physics Education Program, Biology Program, and Biology Education Program at UIN Raden Intan Lampung. The methodology followed the Community-Based Participatory Research (CBPR) approach, which included four key stages: laying the foundation, research planning, information gathering and analysis, and acting on findings (Cassie, 2023; Tremblay et al., 2017). CBPR facilitates hands-on, experience-driven learning. Teachers can participate in real-time writing exercises, receive feedback from peers and mentors, and explore research topics directly relevant to their teaching practice.

Laying the Foundation

During this phase, a survey was administered to identify the challenges faced by educators in publishing scientific research articles. The survey instrument consisted of closed-ended and open-ended questions that explored participants' prior experience in scientific writing, perceived difficulties, and expectations from the training. To ensure content validity, the instrument was reviewed by three faculty members with expertise in physics and biology education, resulting in an average content validity index (CVI) of 0.89, which indicates high validity (Shrotryia & Dhanda, 2019). Reliability was assessed using a pilot test with a subset of five educators, and Cronbach's alpha was calculated at 0.82, indicating good internal consistency (Kennedy, 2022).

The survey results informed the planning of subsequent activities. Coordination efforts were made with the participants to design activities that aligned with their needs, which were then incorporated into the overall timeline of the program. A proposal outlining the planned activities was developed and submitted to UIN Raden Intan Lampung, where faculty members engaged in discussions with the service team to ensure a shared understanding of the objectives and activities.

Research Planning

In this phase, the service team collaborated with the participants to develop a plan to best address the identified challenges. The plan included lectures, discussions, and mentoring sessions focused on scientific writing, specifically utilizing the IMRAD (Introduction, Methods, Results, and Discussion) structure. The collaborative approach ensured that the activities were relevant and tailored to the specific needs of the teachers.

Information Gathering and Analysis

This phase involved implementing the planned activities, including lectures, discussions, and online mentoring. In the first session, participants were trained on scientific writing, focusing on the IMRAD structure. An overview of each component was provided, emphasizing writing standards for accredited national journals. During the discussion session, exemplary scientific articles were analyzed to identify key elements of effective writing, allowing participants to share their experiences and challenges in the writing process. Following the discussion, online mentoring was conducted through a WhatsApp group, providing personalized feedback and technical guidance to participants on their drafts of scientific articles.

Acting on Findings

In this phase, monitoring and evaluation processes were conducted concurrently with the activity implementation. Participants' understanding was assessed using a survey administered before and after the training. It included Likert-scale items and open-ended questions to capture qualitative and quantitative changes in their comprehension of the IMRAD structure. The comparison of pre- and post-training responses showed an increase in participants' confidence and ability to structure their articles effectively.

Additionally, participant reflections during discussion sessions and mentoring interactions provided further qualitative insights into their progress and persistent challenges. Feedback from participants was collected to identify areas for improvement, and when issues or obstacles were identified, corrective actions were taken promptly. This continuous evaluation ensured that the training and mentoring process was refined to meet the needs of the teachers, improving their competencies in scientific writing.

RESULTS AND DISCUSSION

This community service initiative followed the Community-Based Participatory Research (CBPR) approach, encompassing comprehensive stages that allowed for active collaboration with the community of educators and continued feedback for improvement. The Results and Discussion are structured according to the four stages of CBPR: Laying the Foundation, Research Planning, Information Gathering and Analysis, and Acting on Findings.

Laying the Foundation

The preparation phase, which took place from May to July 2024, involved identifying the challenges and issues faced by the educators. This was done through discussions among the community service team and a review of various publications to understand the obstacles encountered by instructors in writing scientific articles. A survey via Google Forms was administered to assess teachers' understanding of the IMRAD structure. The survey results in Figure 1 indicated a lack of familiarity with this method and a general disinterest in writing scientific articles.

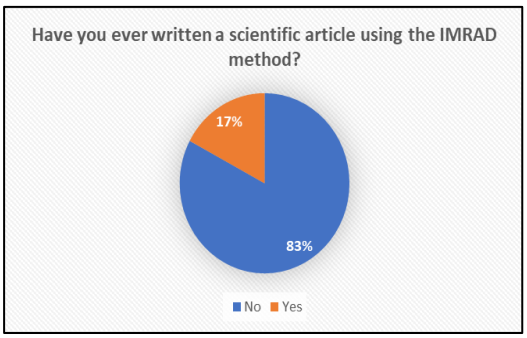

Figure 1 Survey results regarding knowledge of the IMRAD method

This pointed to a clear need for targeted training in scientific writing to improve teacher competence. Additionally, this phase involved the development of training materials based on the IMRAD structure, which were critical to ensuring a structured approach to scientific writing.

Research Planning

During the research planning phase, which also overlapped with the preparation phase, the team developed the implementation timeline, which was set from August 9 to November 30, 2024. A proposal outlining the activities was submitted to UIN Raden Intan Lampung. At this stage, we also developed training materials emphasizing scientific article writing skills utilizing the IMRAD format. The IMRAD section encompasses the following key points:

a. Introduction

This section delineates both ideal and real field circumstances, identifies challenges, proposes alternative solutions, and elucidates the research's uniqueness. Its objective

is to engage the reader's attention regarding the background and significance of the research.

b. Methods
This section delineates the research design, sample characteristics, research instruments (including specific examples), and data analysis methods. It is essential that this section be sufficiently detailed to allow for the replication of the study.

c. Results and Discussion
The results section presents data or findings through tables, graphs, or photographs. The discussion section critically analyses the research findings internally (utilizing the research data) and externally (compared to other studies). This section also addresses the findings' implications, delineates the study's limitations, and offers recommendations for future research.

The training materials are illustrated in Figure 2.

Figure 2 Materials for the IMRAD method training

Information Gathering and Analysis

The activity was conducted from August 9 to November 30, 2024, and included sessions for material presentation, discussions, and mentoring. The training activity began with a presentation on the fundamentals of scientific writing, following guidelines for composing scientific articles. Participants were introduced to the IMRAD structure and effective writing strategies. The initial stage of the training implementation is illustrated in Figure 3.

Figure 3 Implementation of scientific article writing training utilizing the IMRAD method

After attending the presentation and participating in the discussion, participants are expected to understand how to write a quality scientific article suitable for publication. The content concerns fundamental concepts, stages, and methodologies for producing

scientific publications. Following the presentation, participants engaged in a discussion and Q&A session, showcasing their enthusiasm for the topic presented.

Mentoring for the writing of scientific publications is facilitated through a WhatsApp group, providing a flexible and easily accessible option for participants. This initiative commences on August 10, 2024, and will continue until November 29, 2024. The extended timeframe allows participants to receive guidance in stages, corresponding to the progress of their article drafts. The selection of WhatsApp as a communication platform enables participants and mentoring staff to interact swiftly and effectively, allowing for real-time technical input and responses to queries.

Participants in this mentoring program are instructors who have previously engaged with training materials. These resources include comprehensive instructions for crafting scientific articles utilizing the IMRAD structure, with specific strategies for organizing the Introduction, Methods, Results, and Discussion sections. Participants are expected to use the mentoring sessions to refine their article drafts and address particular challenges encountered during the writing process, building upon the foundational knowledge acquired from the training.

During the mentoring program, participants actively submitted drafts of their papers for review by the mentoring team, which provided detailed feedback on the papers' organization, content, and language. This approach helped participants identify areas for improvement and how to address them. Furthermore, WhatsApp groups enabled collective discussions, allowing members to benefit from the feedback provided to others. This aligns with research from Tabar et al. (2023), which revealed that online platforms such as WhatsApp increase the flexibility of mentoring and encourage greater participant involvement than traditional methods.

Mentoring via WhatsApp is also effective because participants are committed to further developing their writing. Those who encounter technical difficulties or struggle to grasp specific concepts can connect directly with the mentoring team, who provide personalized assistance. Additionally, Giacumo et al. (2020) found that ongoing mentorship improves article quality, underscoring the importance of participants engaging in continuous and intensive mentorship sessions.

This mentorship program provides participants the support needed to produce scientific publications that meet established writing standards over nearly four months. The technology-based mentoring methodology has proven effective in helping instructors enhance their scientific writing skills, particularly those with limited availability for in-person sessions. Additionally, this approach offers practical solutions to overcome geographical and time constraints while promoting participant collaboration.

Acting on Findings

Monitoring and evaluation are conducted concurrently with implementing the community service activity. As illustrated in Figure 4, one such monitoring session was held online on November 30, 2024.

Figure 4 Monitoring stage of community service activity

A post-training questionnaire assessed participants' understanding, challenges, and overall satisfaction with the IMRAD structure-based scientific article writing program. The results indicated that 98% of participants had a comprehensive understanding of the fundamentals of scientific article writing upon completing the course. Additionally, 100% of participants reported understanding the purpose of each IMRAD component.

Participants' primary challenges in writing scientific articles were selecting research topics and composing the Introduction section (35%). It is in line with Al-Amien et al., (2022), many individuals face challenges in topic selection due to insufficient experience or inadequate comprehension of contemporary developments within their respective fields. This issue is further exacerbated by the necessity for the selected topic to align with both the interests of the scientific community and the personal interests of the researcher, which may result in conflicts when striving to reconcile innovation with feasibility (El-Sobky, 2021). Furthermore, 20% reported difficulties in developing the Methods section and presenting data, while 45% struggled with interpreting and articulating results in the discussion section, as shown in Figure 5. Many participants expressed a desire for more detailed guidance, either through additional sessions or by using scientific journal samples as references.

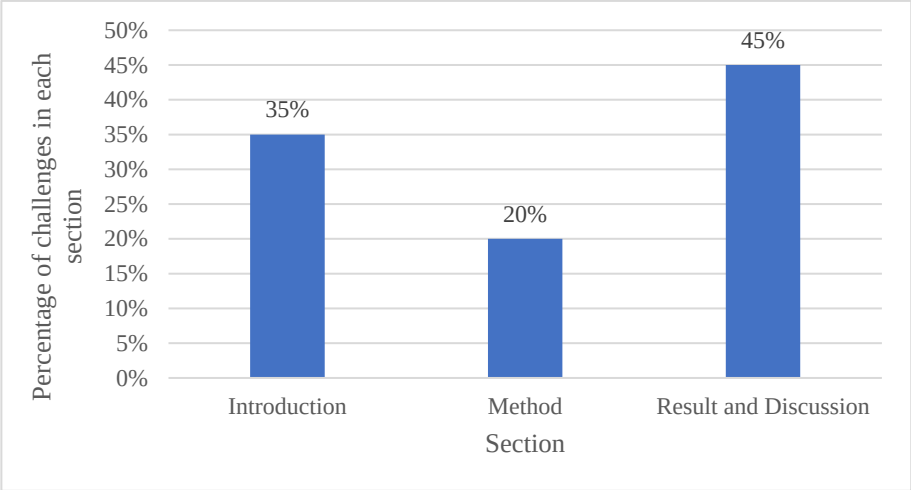

Figure 5 The percentage of challenges in each section

These findings align with Tabuena's (2020) research, which identified similar challenges in writing IMRAD-based publications, particularly with regard to crafting the research background in the Introduction and interpreting and communicating results in the Discussion. The mentoring approach addressed these concerns by providing practical examples and solutions, helping participants overcome these obstacles and significantly improving the quality of their articles. These outcomes corroborate the findings of Prihantoro et al. (2022), who noted that IMRAD-based training coupled with direct mentorship significantly enhanced participants' scientific writing skills.

Strategic initiatives were implemented to address the identified challenges. Additional mentorship meetings via a WhatsApp group were organized to support participants in developing research topics, creating detailed methodologies, and analyzing study results. Participants were also provided a library of IMRAD-structured scientific paper samples to aid their writing. This follow-up approach ensured continued access to resources and guidance as participants worked on their papers.

To illustrate the impact of the training, a comparison table is provided in Table 1.

Table 1 Comparison of participants' competence before and after training

Aspect Evaluated	Before Training (%)	After Training (%)
Understanding IMRAD Structure	20	98
Confidence in Writing Scientific Articles	15	85
Ability to Construct an Introduction	10	65
Clarity in Presenting Research Methods	18	80
Ability to Interpret and Discuss Results	12	75

The evaluation demonstrated that the training effectively enhanced participants' understanding and ability to write IMRAD-based scientific publications. However, ongoing mentorship is necessary for sustained success, particularly focusing on the most challenging sections: the introduction and discussion. With continued support, participants are expected to produce high-quality scientific articles, enhancing their chances of publication in reputable scientific journals. These outcomes corroborate the findings of Mayyas & Alzoubi (2022) and Piran & Tran (2024), who noted that IMRAD-based training and direct mentorship significantly enhanced participants' scientific writing skills.

CONCLUSION

This community service significantly enhanced the research writing competencies of physics and biology educators by providing practical coaching grounded in the IMRAD (Introduction, Methods, Results, and Discussion) framework. Participants gained a deeper understanding of the structured nature of scientific writing through a comprehensive training program that included lectures, discussions, and online guidance. Evaluation results indicated a notable improvement in participants' comprehension of the IMRAD format, with a majority reporting increased confidence in their ability to produce scientific publications. However, persistent challenges were observed, particularly in composing the Introduction and Discussion sections, which require additional attention due to their demand for critical thinking, coherence, and engagement with existing literature. Moreover, while the training led to short-term improvements, its long-term impact on publication rates remains uncertain, highlighting the need for sustained mentoring and institutional support.

The effective implementation of the IMRAD-based writing workshop demonstrates that methodical and structured approaches can enhance teachers' research productivity, especially in contexts where academic mentorship is limited. This model could be adapted and applied in broader educational settings, particularly in regions where faculty members face similar barriers to publishing. Institutions in other provinces or countries could benefit from integrating structured writing support into their faculty development programs, potentially fostering a more research-active academic culture.

Future research could employ longitudinal studies to monitor instructors' publication progress over time, thereby examining the long-term effects of these workshops. A more nuanced understanding of the most effective strategies for academic writing interventions may emerge from investigating the influence of peer collaboration, institutional support, and sustained mentoring on teachers' ability to publish in reputable journals. Additionally, research contrasting various educational systems could validate the adaptability and effectiveness of the IMRAD-based workshop model across diverse academic environments.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, ASM, ASH, and NDA; methodology, NJF; formal analysis, FA; writing—preparation of the original draft, NJF and FA.

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