International Journal of Language Pedagogy
Vol. 5, No. 1, pp 106-116, May 2025
E-ISSN 2777-1229, P-ISSN 2797-1783
DOI: https://doi.org/10.24036//ijolp.v5i1.97

Validity of 5E-PBL Learning Cycle Model Based on TPACK to Improve Scientific Writing

Khairun Nisa[1)], Norliza Jamaluddin[2)], Joseline M. Santos[3)]
[1)]Universitas Asahan, Kisaran, Indonesia
[2)]Universiti Pendidikan Sultan Indris, Malaysia
[3)]Bulacan State University, Philippines
*Corresponding Author, email: nisakhairun2206@gmail.com

Received: March, 30, 2025 Revised: April, 29, 2025 Accepted: May, 29, 2025

Abstract

Scientific writing is a critical skill for students and educators, yet many continue to face substantial challenges in meeting academic writing standards. Studies reveal that only 14.25% of students are able to develop ideas supported by data analysis, while 66.67% struggle to express their thoughts in structured academic formats. Common difficulties include formulating and organizing ideas, using proper academic language, and referencing accurately. To address these issues, this study developed and validated the TPACK-based 5E-PBL Learning Cycle Model, aiming to enhance students' scientific writing abilities. Employing the Plomp R&D model, the research proceeded through three phases: preliminary investigation, development and prototyping, and evaluation. Expert validation showed high content validity, with scores of 3.51 (88%) for model content, 3.52 (88%) for the model book, and 4.34 (87%) for the student guidebook. Implementation results indicate that the model effectively improves students' understanding of scientific writing structures, fosters critical thinking, and encourages meaningful integration of technology. This study concludes that the 5E-PBL Learning Cycle Model based on TPACK is a valid and feasible approach to address academic writing challenges. Further research is recommended to evaluate its broader impact across disciplines.

Keywords: 5E Learning Cycle Model, Problem-Based Learning (PBL), TPACK, Scientific Article Writing, Model Validity

Introduction

The ability to write scientific articles is an essential skill for students and educators in the academic world (Oktavia et al., 2024; Sabrina et al., 2022). However, various studies show that many students have difficulty writing scientific articles that are in accordance with academic rules (Ahmad et al., 2023; Sukenti et al., 2024; Sulaiman & Muhajir, 2019). Research on students' understanding of academic writing shows varied results. A study found that only 14.25% of students were able to develop ideas with data literacy at an analysis stage of 19% (Maulidah et al., 2023). Additionally, 66.67% of students struggled to articulate their ideas in academic writing, indicating a low level of proficiency in scientific writing (Purnamasari, 2023). During the pandemic, academic writing difficulties increased, with 81.8% of students reporting academic challenges and 18.2% facing non-academic obstacles (Syahputri, 2022). These findings emphasize that the majority of students still encounter significant challenges in effectively developing their academic writing skills. The persistently low levels of academic literacy, as shown by these statistics, highlight an urgent need for a learning solution that not only addresses cognitive and technical writing difficulties but also integrates pedagogical and

technological strategies to systematically enhance writing proficiency. Hence, a model that combines multiple, research-backed learning approaches is essential to fill this educational gap. These difficulties include aspects such as formulating ideas, organizing ideas, and using appropriate references and language (Novitri et al., 2023).

Factors that contribute to this problem include a lack of understanding of the structure of scientific writing, low digital literacy, and a lack of effective guidance in the learning process (Jatmoko et al., 2023). In addition, students often face obstacles in gathering ideas for their final projects, the ability to write scientific papers, and collecting reading sources (Kim et al., 2025). Lack of motivation, time constraints, and lack of references are also significant obstacles to writing scientific articles (Song & Song, 2023).

To overcome these obstacles, collaborative efforts are needed between students and lecturers. Effective training and guidance can help improve students' scientific writing skills. For example, the "Write For Go Publish" program has been implemented to train students to write scientific articles in reputable journals (Novaryatiin et al., 2024). In addition, activities such as the "Academic Writing Series" are designed to help lecturers overcome difficulties in writing and publishing scientific papers (Jubba et al., 2023). Thus, increasing digital literacy and access to adequate reference sources are also key in supporting the ability to write quality scientific articles.

To overcome the challenges of improving the ability to write scientific articles, innovative learning models that integrate a comprehensive approach are needed. One approach that has been proven effective in improving critical thinking and problem-solving skills is a combination of the 5E learning cycles (Engage, Explore, Explain, Elaborate, Evaluate) and Problem-Based Learning (PBL) (Kaewmanee et al., 2024). The 5E learning cycle is designed to facilitate student-centred learning through five stages, namely Engage**,** which aims to attract students' interest and curiosity towards the topic to be studied, and Explore**,** which provides opportunities for students to investigate concepts through hands-on activities. Explain**,** which encourages students to articulate their understanding and receive formal explanations from the teacher; Elaborate, which expands students' understanding by applying concepts in new situations; and Evaluate, which functions to assess students' understanding and skills related to the concepts learned (Lasaiba & Lasaiba, 2024).

Research shows that the application of the 5E learning cycle model can improve students' critical thinking skills. For example, a study found that this model was effective in improving student activities and learning outcomes, with an increase in learning completeness from 72.5% in the first cycle to 85.0% in the second cycle (Lasaiba & Lasaiba, 2024). In addition, the Problem-Based Learning (PBL) approach is also effective in placing real problems as a context for students to develop problem-solving and critical thinking skills. PBL encourages students to learn independently, work in groups, and find solutions that contribute to the improvement of critical thinking skills (Nargundkar et al., 2014). Other studies show that PBL can significantly improve learning outcomes. For example, research by (Firdaus et al., 2015) found that PBL can improve students' critical thinking skills in mathematics learning.

The integration of 5E, PBL, and TPACK is grounded in the complementary strengths of each approach. While the 5E model structures learning in an inquiry-based and iterative fashion, PBL situates learners in real-world problem contexts that stimulate deeper engagement and critical thinking. TPACK, on the other hand, supports the pedagogical and technological scaffolding required to transform abstract knowledge into practical, technology-supported learning experiences. Previous studies (Koh et al., 2014; Elander et al., 2006) have demonstrated that combining inquiry-based structures with problem orientation and digital tools enhances learners' academic writing skills by fostering analytical thinking, idea organization, and the ability to use research tools effectively. This synthesis is particularly

relevant for developing students' academic writing, where the interplay between conceptual understanding, problem engagement, and digital competence is critical.

By combining the 5E and PBL learning cycles, it is hoped that students can be actively involved in the learning process, build understanding gradually, and apply the concepts learned to solve real problems. This approach is believed to improve the ability to write scientific articles because it encourages students to think analytically, systematically, and creatively in compiling academic ideas and arguments.

In addition, the application of Technological Pedagogical Content Knowledge (TPACK) in this learning model provides a strong foundation for the integration of technology in the process of writing scientific articles. TPACK ensures that educators not only master the material and pedagogy but are also able to optimize technology to improve the quality of learning (Koehler et al., 2011; Syafitri et al., 2024). Research shows that the implementation of TPACK can increase teachers' creativity, enrich students' learning experiences, and improve students' academic and non-academic outcomes (Ramdhanianty & Zolkafil, 2024). Thus, the use of the TPACK-based 5E-PBL Learning Cycle Model is believed to be an innovative solution for improving the ability to write scientific articles.

Before learning models such as the TPACK-based 5E-PBL Learning Cycle can be widely applied, a validity study is needed to ensure that the model has a strong theoretical basis and can be applied effectively in the context of scientific writing learning. Validation of the learning model involves evaluating aspects such as the validity of the content, its construction, and its practical application in real learning situations. Previous research has shown that the application of the TPACK-based Problem-Based Learning model is effective in improving students' critical, communicative, collaborative, and creative thinking competencies, all of which are important elements in scientific writing skills (Chaniago et al., 2024). Therefore, this study aims to (1) test the validity of the TPACK-based 5E-PBL Learning Cycle Model and (2) examine its initial effectiveness in enhancing students' scientific article writing skills through classroom implementation.

Although previous studies have demonstrated the partial effectiveness of 5E, PBL, and TPACK in various domains, few have investigated their combined application specifically for scientific writing. Existing models often focus solely on cognitive strategies or tool usage, without systematically integrating inquiry stages, real-world problem contexts, and technological scaffolding. This study fills the gap by proposing a unified model that combines the structured inquiry of 5E, the real-world engagement of PBL, and the integrative instructional design of TPACK to directly target scientific writing skills—a domain that requires not only conceptual clarity but also structured problem-solving and technological fluency.

Methods

This study uses a research and development (R&D) approach adapted from the Plomp development model**,** consisting of three main stages: (1) Preliminary Research, (2) Development and Prototyping, and (3) Evaluation (Plomp, 2013). The main purpose of this study is twofold: first, to test the validity of the TPACK-based 5E-PBL Learning Cycle Model; and second, to explore its initial effectiveness in improving scientific writing skills through a comparative analysis involving experimental and control classes. This extended scope aims to ensure that the model is not only theoretically and structurally valid but also pedagogically impactful in real classroom contexts. In the initial investigation, a needs analysis is carried out to understand the problems faced in learning scientific writing and determine the characteristics of the appropriate model. The second stage, Development and Prototyping, involves designing a learning model that integrates the 5E learning cycle with TPACK-based Problem-Based

Learning (PBL). The third stage, Evaluation, focuses on the validation of the model by experts and readability tests by prospective users, namely teachers and students.

At the needs analysis stage, the research subjects involved 30 students in the first semester of the 2022/2023 Academic Year Faculty of Law, Asahan University, who were taking Indonesian courses. This stage aims to explore the needs, shortcomings, and desires of students in learning to write scientific articles. Furthermore, in the trial stage, the research subjects consisted of two groups, namely the control class and the experimental class. The control class, namely the first semester of the 2022/2023 academic year, the Development Economics Study Program, Asahan University, has 27 people, of which there is only one class. The experimental class was selected from one of the seven classes in the first semester of the 2022/2023 Academic Year of the Management Study Program, which totalled 30 students. The selection of this class is carried out *purposively* by considering the suitability of the learning characteristics in the Management Study Program, which is active and creative so that it is relevant to the application of the TPACK-based 5E-PBL learning cycle model. With a balanced number of students between the control and experimental classes, this study ensures the feasibility of learning management as well as adequate data representation. This combination of subjects from various fields of study is designed to explore the generalization and effectiveness of learning models on the development of scientific writing skills.

The expert validation sheet consisted of 25 indicators covering content relevance, theoretical alignment, language clarity, and media attractiveness, rated on a 4-point Likert scale. The student and lecturer perception questionnaire included 10 items focusing on clarity, usefulness, ease of use, and engagement, each rated from 1 (strongly disagree) to 5 (strongly agree). Semi-structured interviews explored user impressions, challenges, and suggestions for model improvement.

Data collection was carried out through expert validation using model validation sheets, perception questionnaires to measure the understanding and suitability of the model by teachers and students, and in-depth interviews to obtain qualitative feedback. The collected data is quantitatively analyzed using the Content Validity Index (CVI) to assess the validity level of the model and qualitative analysis to interpret input from validators and potential users. This study aims to ensure that the model developed has a strong theoretical basis and can be applied effectively in the context of learning scientific writing. Validation of the learning model is very important to ensure its effectiveness in improving student competence, as revealed by (Irawan et al., 2023) in their research on the application of the TPACK-based Problem-Based Learning model. Thus, it is hoped that the TPACK-based 5E-PBL Learning Cycle Model can be an innovative solution to improving the ability to write scientific articles systematically and sustainably.

Although the research was initially framed as a validation study, the inclusion of a control and experimental group for comparative purposes signifies a preliminary effectiveness phase. Therefore, the methodology integrates both model validation—through expert judgment and user readability testing—and exploratory effectiveness testing—through student performance comparisons. This clarification aligns the research design with its actual implementation and ensures the accuracy of result interpretation.

Result and Discussion

This study employed a Research and Development (R&D) methodology adapted from the Plomp model, comprising three stages: preliminary research, development and prototyping, and evaluation. The focus of this section is on the evaluation stage, particularly the validity testing of the TPACK-based 5E-PBL Learning Cycle Model, which was conducted through expert validation and user perception analysis.

The products developed include model books and manuals. Below is a description of the development results of each product.

1. Model Book Validation Results

The validation of the TPACK-based 5E-PBL learning cycle model book was carried out through discussions with experts held online from September to November 2022. The results of the validation can be observed below.

a. Model Book Design

The initial design of the model book is considered to be attractive to students. However, on the front cover of the guidebook, it is necessary to consider the layout and size of the images (especially those in the circle, the sorting of images can also lead to identical to scientific articles in addition to technological descriptions such as sheets written on articles or journals or proceedings as characteristics), good and correct font size and writing, especially on the back cover of the book. Next, it is necessary to be consistent in the size of the images in the book.

In addition, the results of the validation of the learning model carried out by experts as a whole were obtained, on average, 3.52 with a percentage of 88% (Table 1), including the very valid category. The results are seen from the aspects of suitability of objectives, attractiveness of media, suitability of materials, completeness of materials, completeness of evaluation, giving *feedback*, and accuracy of language use. This is based on the validation of three experts who stated that the TPACK-based 5E-PBL learning cycle model is valid.

Table 1. Data on Model Book Validation Results by Validators

No	Validator	Assessed Aspects								Average
		1	2	3	4	5	6	7	8	
1	Validator 1 (Indonesian Language Teaching)	4	3,6	4	4	3,7	3,3	4	3,7	3,74
2	Validator 2 (Learning Media)	3,6	4	4	4	4	4	4	4	3,94
3	Validator 3 (Graphics)	3	2,8	3	3	2,5	2,5	3,3	3,3	2,78
	Total Average									3,52
	Percentage									88%

Based on Table 1 above, it can be known that the results of the validation of the model book assessed by the validator with the category are very valid. From the aspects assessed, the average score as a whole was 3.52. The Indonesian teaching aspect of the model book received a score of 3.74 with a very valid category; the learning media aspect received a score of 3.94 with a very valid category; and the graphic aspect with a score of 2.78 with a valid category.

The table shows that the developed guidebook is very valid. Therefore, it can be used as a learning resource for students in writing scientific articles. In addition, model books are compiled to help facilitate understanding and improve students' proficiency in writing scientific articles.

The cover of the TPACK-Based 5E-PBL Learning Cycle Model to Improve Scientific Article Writing Proficiency contains an identity consisting of the title of the model book; the approach used, and the identity of the author of the teaching material. In addition to the identity, the cover of this model's book is also equipped with an image. The purpose of this image is to attract the reader's attention so that it is easy to understand the contents of the model book better. After consulting and validating the model book, the model book development process has undergone slight improvements. The improvement is related to the adjustment of the name of

the book title so that there is a revision on the cover. The cover of the model book can be seen in Figure 1 below.

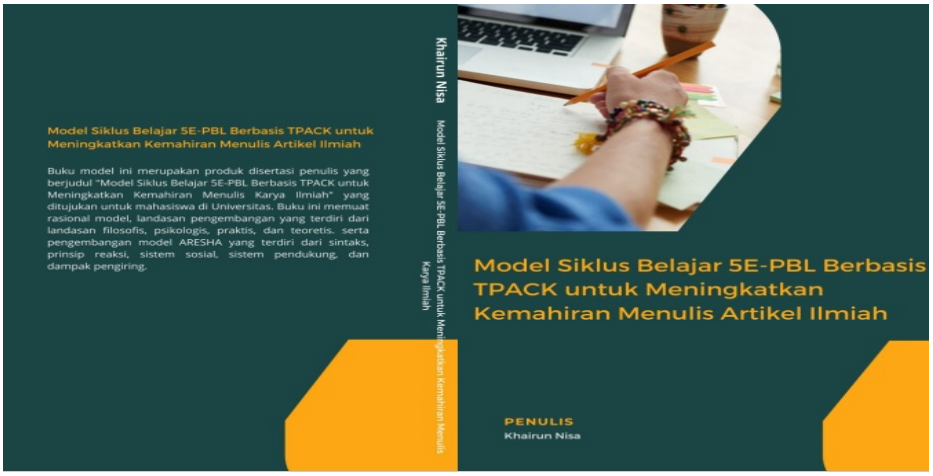

Figure 1. Model Book Cover

2. Handbook Validation Results

The guidebook that has been developed is validated by validators in accordance with the advice of the supervisor based on their respective expertise. Before being validated, the guidebook that was created underwent a slight revision according to the results of the validation by experts. Two expert validators validated the guidebook.

b. Handbook Design

The initial design of the guidebook has been assessed by experts and stated to be attractive and does not require much improvement. The advice conveyed by the expert is to pay attention to the writing system in the content of the guidebook. For example, on page 24, there are differences in writing *style*; the first letter is written with capital letters, and some are not. In addition, experts suggest that the effectiveness of sentences in some parts also needs to be improved.

Furthermore, the results of the validation of the guidebook carried out by experts as a whole were obtained an average of 4.34 with a percentage of 87% (Table 2), which is included in the category of very valid. The results are seen from the aspects of suitability of objectives, attractiveness of media, suitability of materials, completeness of materials, completeness of evaluation, giving *feedback*, and accuracy of language use. This is based on the validation of three experts who stated that the guidebook for students in writing scientific articles is very valid.

Table 2. Data of Guidebook Validation Results by Validators

No	Validator	Assessed Aspects					Average
		1	2	3	4	5	
1	Abdurrahman (Indonesian Language Teaching)	5,0	5,0	4,33	4,5	5,0	4,77
2	Cintya Nurika Irma (Learning Media)	4,5	4,5	4,0	4,5	4,67	4,43
3	Sri Rahayu (Graphics)	4,25	4,0	3,33	3,5	4,0	3,82
	Total Average						4,34
	Percentage						87%

Based on Table 2, the results of the validation of the guidebook by the validator show that the category is very valid. The average grade for the entire material is 4.34. Specifically, the Indonesian teaching aspect in the guidebook received a score of 4.77 with a very valid category, the learning media aspect reached a score of 4.43 with a very valid category, while the graphic aspect obtained a score of 3.82 with a valid category. The table shows that the developed guidebook is very valid, so that it can be used as a learning resource in writing scientific articles. The handbook is compiled to help facilitate understanding and improve the writing skills of scientific articles.

After consulting and validating the manual, the development process of the manual has been improved on the cover. Figure 2 shows the cover of the guidebook

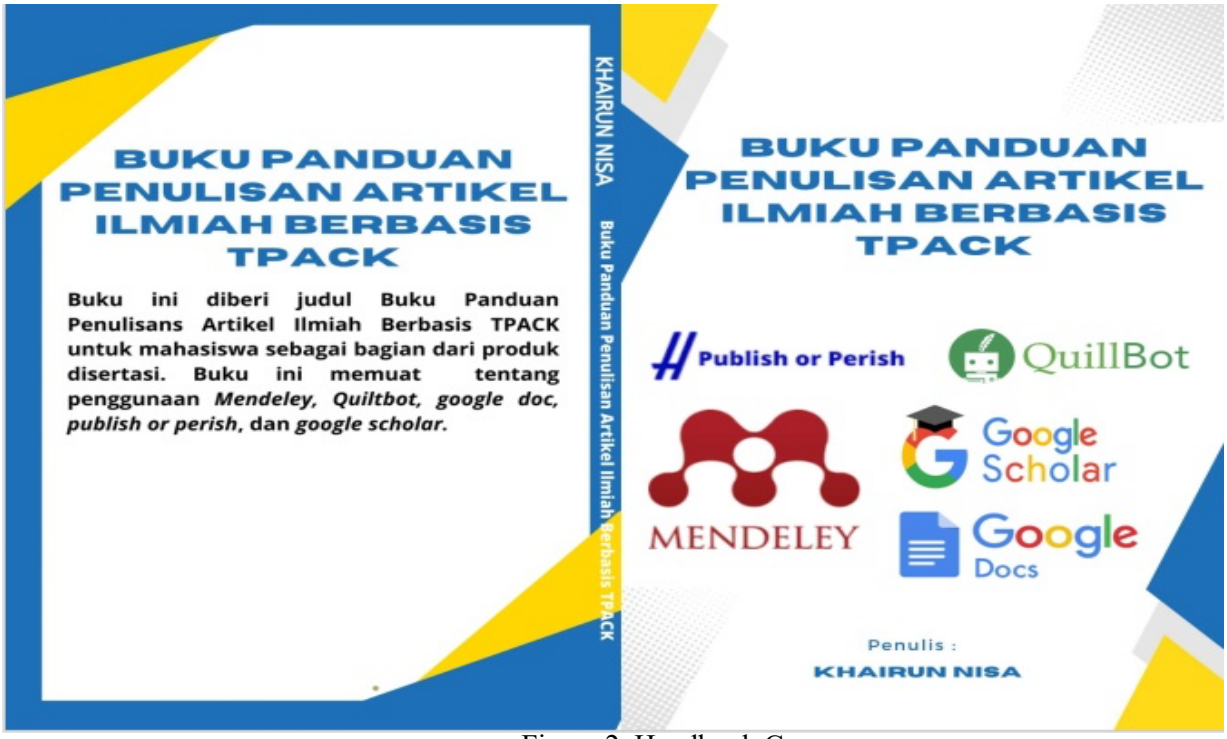

Figure 2. Handbook Cover

The trial was carried out on December 13 and 15, 2022, at Asahan University by one lecturer of the Indonesian language course. The implementation of the trial is related to the development of a TPACK-based 5E-PBL learning cycle model. The lecturer gave the following response or opinion.

"The ability to write scientific articles of Asahan University students is already good. However, in learning, there are still students who use the old writing style. The learning model used is very interesting because students understand how to write scientific articles. The learning model is valid. The learning model is in accordance with the context of the use of media in the campus curriculum, which is already familiar. The learning model used is very helpful for students to improve their scientific article writing skills. As a lecturer, I am happy with the use of learning media on campus".

The obstacles in writing scientific articles are not only limited to the learning model but also include the need for many reference materials. One of the needs of students when writing scientific articles is the need for supporting technology to facilitate the process of finding ideas based on references and writing techniques (Nisa et al., 2023, 2022). The use of the TPACK-based 5E-PBL learning cycle model is very helpful in practising students' scientific article writing skills. This model also increases their enthusiasm for learning and can motivate them to be more creative and courageous in utilizing technology.

Furthermore, two students from the experimental class and two students from the control class provided suggestions or comments on the TPACK-based 5E-PBL learning cycle learning model presented. The first student (experimental class) commented, "It is recommended that the TPACK-based 5E-PBL learning cycle model be equipped with a snippet of how to use the application to be used." The second student commented (experimental class), "The TPACK-based 5E-PBL learning cycle model should have a lighter colour composition so that it is more attractive and easy to understand". Meanwhile, the comment from the first student (control class) was, "It is necessary to simplify the explanation of the solution to every difficulty in writing scientific articles." A comment from the second student from the control class, "The language presented should be simplified to make it easier for first-year students to understand."

Although the study is primarily oriented toward validating the model, the inclusion of experimental and control classes also enables a preliminary assessment of its pedagogical impact in real classroom settings.

3. Expert Validation Results

Validation was conducted by three expert reviewers in the fields of instructional media, Indonesian language education, and educational graphics. The instrument used in expert validation consisted of 25 indicators encompassing content relevance, theoretical integration, clarity of language, syntax accuracy, and media appeal. Each indicator was rated on a 4-point Likert scale. The aggregated validation results show that the model book achieved an average score of 3.52 (88%), while the student handbook obtained a higher score of 4.34 (87%)**.**

Tabel 3. Expert Validation Results

Component Evaluated	Average Score	Validity Category
Model Book	3.52 (88%)	Very Valid
Student Handbook	4.34 (87%)	Very Valid

Specific feedback from experts suggested minor improvements in the alignment of supporting theories with practical learning tools, and consistency in graphic layout and terminology. These suggestions were addressed through revisions in the instructional materials, ensuring greater coherence and usability.

4. User Perception and Readability

Readability tests were conducted with both lecturers and students. Perception questionnaires consisted of 10 items measuring the clarity, usefulness, ease of use, and engagement of the model. Qualitative feedback was also obtained through semi-structured interviews to capture impressions, challenges, and recommendations. Students from the experimental class reported that the model helped them better understand the structure of scientific writing, while also increasing their motivation to write. Suggestions for improvement included simplifying technical language and providing illustrative examples of digital tools for writing support.

Lecturer responses further reinforced the model's applicability. One lecturer stated:

"This model is highly relevant to our instructional context. It not only enhances students' understanding of scientific article writing but also integrates well with the media and learning environment on campus."

These findings support the claim that the model is pedagogically impactful and relevant to the needs of both students and instructors

Discussion

The research findings indicate that the 5E-PBL Learning Cycle Model based on TPACK has a high level of validity and is feasible for implementation in scientific writing instruction.

Expert validation confirms that this model possesses clear syntax, aligns with TPACK principles, and is relevant in supporting academic writing skills. Therefore, this model is expected to provide a solution to various challenges in scientific writing instruction, such as low academic literacy and the lack of effective guidance for students.

The 5E-PBL Learning Cycle Model based on TPACK integrates the 5E learning cycle (Engage, Explore, Explain, Elaborate, Evaluate) with Problem-Based Learning (PBL), which has been proven effective in enhancing critical thinking and problem-solving skills (Amanda et al., 2024). In this study, model validation showed that usability and effectiveness aspects received an average score of 3.51 (88%) for model content validity and 3.52 (88%) for the model book. These figures indicate that the model has a very high level of validity and can be effectively utilized in academic writing instruction.

A previous study by Pramestika et al., (2020) found that the application of PBL enhances students' critical thinking skills in mathematics learning. This finding aligns with the present study's results, which demonstrate that the integration of PBL in the 5E Learning Cycle based on TPACK not only improves conceptual understanding but also facilitates students in developing more systematic and evidence-based academic writing skills.

Additionally, the application of TPACK in this model allows for the optimal utilization of technology in scientific writing instruction. Research by Koh et al., (2014) indicates that implementing TPACK in education enhances teacher creativity and enriches student learning experiences. In this study, TPACK helps students access digital references, use academic writing software, and optimize tools such as reference management software. This contributes to greater efficiency in the academic writing process.

Furthermore, the validation of the instructional guidebook developed in this study obtained an average score of 4.34 (87%), indicating that it is highly valid for use as a learning resource. This is supported by Elander et al., (2006), who emphasize the importance of comprehensive supporting materials in improving students' understanding of academic writing skills. In the readability test, students reported that this model helped them understand the structure of scientific writing while enhancing their critical and analytical thinking skills.

Although the research findings indicate that the model has a high level of validity, certain aspects need to be considered for further implementation. Some students suggested that the model should include technical guidance on the use of writing-support applications and that the language in the instructional guidebook should be simplified for beginner-level students. Additionally, further research is needed to examine the effectiveness of this model in broader contexts, such as in various academic disciplines or different educational institutions.

Considering these research findings and previous studies, the 5E-PBL Learning Cycle Model based on TPACK can be regarded as an innovative approach to scientific writing instruction. The integration of the 5E Learning Cycle, Problem-Based Learning, and TPACK has been proven to positively impact students' academic writing skills in terms of conceptual understanding, writing structure, and the use of technology in the writing process. Therefore, the implementation of this model in academic writing instruction is recommended for broader adoption to support the systematic and sustainable enhancement of students' academic literacy.

One limitation of this study is its focus on a single institution—Asahan University—and three study programs. While this setting provided contextual relevance and ease of control, it limits generalizability. Further validation involving diverse institutions and disciplines is needed to confirm the model's applicability across broader academic contexts.

Conclusion

Based on the results of the study, it can be concluded that the TPACK-based 5E-PBL Learning Cycle Model has high validity in improving the ability to write scientific articles. The results of validation by experts show that this model has clarity of syntax, conformity with

TPACK principles, and relevance in supporting scientific writing skills. In addition, the validation of the model book and guidebook also obtained a very valid category, which shows that the developed learning tools can be used effectively in the learning process. The application of the TPACK-based 5E-PBL Learning Cycle Model in learning not only helps improve students' scientific writing skills but also encourages active involvement, critical thinking, and the use of technology in the learning process. The readability test by students and lecturers shows that this model can be applied well in various disciplines, especially in supporting academic literacy-based learning. Thus, this study confirms that the TPACK-based 5E-PBL Learning Cycle Model is an innovative approach that can be widely implemented to improve scientific writing skills. However, for further application, further research is recommended to examine the effectiveness of this model on a larger scale and in a variety of different learning contexts. Thus, the model is considered a valid and feasible tool to support the improvement of scientific writing skills within the tested context**.** However, its broader applicability across disciplines and institutions requires further empirical testing.

References

Ahmad, A., Mukhaiyar, Atmazaki, & Johari, A. (2023). Practical Used of Essay Writing Material based PjBL through Padlet in Higher Education. *International Journal of Language Pedagogy*, *3*(2), 10–17. https://doi.org/10.24036/ijolp.v3i2.43

Amanda, F. F., Sumitro, S. B., Lestari, S. R., & Ibrohim, I. (2024). Enhancing critical thinking and problem solving skills by complexity science-problem based learning model. *REMIE: Multidisciplinary Journal of Educational Research*, *14*(1), 96–114.

Elander, J., Harrington, K., Norton, L., Robinson, H., & Reddy, P. (2006). Complex skills and academic writing: a review of evidence about the types of learning required to meet core assessment criteria. *Assessment & Evaluation in Higher Education*, *31*(1), 71–90.

Firdaus, F., Kailani, I., Bakar, M. N. Bin, & Bakry, B. (2015). Developing critical thinking skills of students in mathematics learning. *Journal of Education and Learning (EduLearn)*, *9*(3), 226–236.

Irawan, M., Ginting, R., Nainggolan, E., & Matondang, I. (2023). Exploration and Validation of Lecturer Competency Models in Case Method Based Learning and Project Based Learning. *Proceedings of the 4th International Conference on Science Education in The Industrial Revolution*, *4*.

Jatmoko, D., Suyitno, S., Rasul, M. S., Nurtanto, M., Kholifah, N., Masek, A., & Nur, H. R. (2023). The Factors Influencing Digital Literacy Practice in Vocational Education: A Structural Equation Modeling Approach. *European Journal of Educational Research*, *12*(2).

Jubba, H., Saka, P. A., Qodir, Z., Hidayati, M., Pabbajah, M., & Dzinnun, Y. (2023). Mengatasi Kesulitan Menulis Artikel Ilmiah Melalui Kegiatan Academic Writing Series. *Nawadeepa: Jurnal Pengabdian Masyarakat*, 142–150.

Kaewmanee, T., Srisenpila, A., & Worapun, W. (2024). Integrating 5E inquiry-based learning and STEM education to enhance grade 5 students' science process skills and achievement in friction. *Inquiry*.

Kim, J., Yu, S., Detrick, R., & Li, N. (2025). Exploring students' perspectives on generative AI-assisted academic writing. *Education and Information Technologies*, *30*(1), 1265–1300.

Koehler, M. J., Mishra, P., Bouck, E. C., DeSchryver, M., Kereluik, K., Shin, T. S., & Wolf, L. G. (2011). Deep-play: Developing TPACK for 21st century teachers. *International Journal of Learning Technology*, *6*(2), 146–163.

Koh, J. H. L., Chai, C. S., & Tay, L. Y. (2014). TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge

(TPACK). *Computers & Education*, *78*, 20–29.

Lasaiba, M. A., & Lasaiba, D. (2024). Enhancing Academic Achievement Through the Application of the 5E Learning Cycle Model. *INSECTA: Integrative Science Education and Teaching Activity Journal*, *5*(1), 71–86.

Nargundkar, S., Samaddar, S., & Mukhopadhyay, S. (2014). A guided problem-based learning (PBL) approach: Impact on critical thinking. *Decision Sciences Journal of Innovative Education*, *12*(2), 91–108.

Nisa, K., Ramadhan, S., & Thahar, H. E. (2023). Writing scientific articles for undergraduate students: A need analysis. *International Journal of Evaluation and Research in Education*, *12*(3), 1696–1704. https://doi.org/10.11591/ijere.v12i3.24999

Nisa, K., Ramadhan, S., & Thahar, H. E. (2022). Student Perceptions of Technology Needs in Scientific Writing. *Proceedings of the 5th International Conference on Language, Literature, and Education (ICLLE-5 2022)*, 287–295. https://doi.org/10.2991/978-2-494069-85-5

Novaryatiin, S., Ardhany, S. D., & Purnama, A. (2024). Write For Go Publish: Pelatihan Penulisan Artikel Ilmiah Pada Jurnal Internasional Bereputasi Bagi Mahasiswa Prodi Kehutanan Universitas Muhammadiyah Palangkaraya: Write for Go Publish: Training in Writing Scientific Articles in Reputable International Jo. *Majalah Cendekia Mengabdi*, *2*(1), 14–24.

Novitri, S., Rusli, S. M., Putri, R., Ardi, H., Juita, N., & Bulan, L. S. (2023). Revitalization of Language Learning Management through Mobile Learning. *International Journal of Language Pedagogy*, *3*(1), 29–38.

Oktavia, Y., Atmazaki, Zaim, M., Alpino, S., & Marpuah, S. (2024). Need Analysis of the Model for Writing Scientific Articles. *International Journal of Language Pedagogy*, *4*(1), 73–81.

Plomp, T. (2013). Educational design research: An introduction. *Educational Design Research*, 11–50.

Pramestika, N. P. D., Wulandari, I. G. A. A., & Sujana, I. W. (2020). Enhancement of mathematics critical thinking skills through problem based learning assisted with concrete media. *Journal of Education Technology*, *4*(3), 254–263.

Ramdhanianty, G., & Zolkafil, S. (2024). The Application Of Technological Pedagogical Content Knowledge In Arabic Language Learning Among Universities. *Jurnal Islam Dan Masyarakat Kontemporari*, *25*(2), 45–52.

Sabrina, R., Sulasmi, E., & Saragih, M. (2022). Student Critical Thinking Skills and Student Writing Ability: The Role of Teachers' Intellectual Skills and Student Learning. *Cypriot Journal of Educational Sciences*, *17*(7), 2493–2510.

Song, C., & Song, Y. (2023). Enhancing academic writing skills and motivation: assessing the efficacy of ChatGPT in AI-assisted language learning for EFL students. *Frontiers in Psychology*, *14*, 1260843.

Sukenti, D., Agustina, Fauzan, A., & Ramli, N. binti. (2024). Development of Writing Assessment Skills with Psychosocial Involvement for Indonesian Language Teachers. *International Journal of Language Pedagogy*, *4*(1), 52–64.

Sulaiman, R., & Muhajir, M. (2019). The difficulties of writing scientific work at the English education students. *Journal of English Education*, *4*(1), 54–60.

Syafitri, W., M. Zaim, Ardi, H., & Artika, F. S. (2024). Optimizing TPACK in Economics English: A Textbook Analysis. *International Journal of Language Pedagogy*, *4*(2), 82–90.