Development of the BROSING Model in Scientific Article Writing Learning

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***Abstract*—This research aimed to develop the BROSING model (bibliographic exploration, research synthesis, objective examination, study analysis, idea generation, narrative development, and goal-driven publishing) to enhance students' scientific article writing skills. The study used the Plomp development model, which included preliminary research, prototype development, and evaluation, resulting in a prototype design. In addition, a quantitative method was used in the evaluation phase. Three education experts and one technology expert were consulted to assess validity and practicality, using purposive sampling. The evaluation involved 26 students in the experimental class and 29 in the control class from Universitas Putera Batam, selected using random sampling. Preliminary research included a needs analysis, with experts evaluating the curriculum and students assessing needs in Creative Problem Solving (CPS) and Creative Thinking Skills (CTS). Model development produced several products, including a model, lecturer, and student books, and an e-learning platform to support blended learning. These products underwent expert validation in multiple phases until a final prototype was developed. Following that, an evaluation was conducted on the prototype through implementation in a learning environment. Expert validity tests yielded high results, as did practicality and effectiveness tests, confirming the effectiveness of the BROSING model in enhancing scientific article writing skills. The t-test results emphasize the significant impact of applying the BROSING model in learning scientific article writing (t_{ob} = 5.055 > t_{cv} = 1.674; α = 0.05).**

***Keywords*—writing scientific articles, BROSING model, creative thinking skills, undergraduate learning**

I. Introduction

Learning to write scientific articles is essential for university students. However, based on a preliminary study, writing skills have become a concern for students. Students face challenges in generating and developing ideas when writing scientific articles. Despite the need for creative expression in scientific article writing, students struggle to articulate their ideas effectively. One issue that students face is the lack of confidence in developing their oral ideas into a scientific paper [1]. Additionally, they may struggle with finding suitable scientific article topics.

Moreover, students are directed to possess skills and experience in creatively writing scientific articles [2]. However, in reality, students face challenges in determining scientific article topics and are not yet able to write scientific articles creatively, adhering to the correct rules and writing systematics. The writing systematics in scientific articles include the introduction, literature review, methodology, research findings, discussion, conclusion [3, 4], and utilizing the Mendeley APA style 7th [5]. Limited reading interest among students may be attributed to challenges in attending classes while working, resulting in minimal time to expand their insights and a lack of intensive training. Consequently, students struggle to articulate their thoughts in writing scientific articles. According to Sahmini and Rostikawati [6], scientific writing is crucial as it examines knowledge and is written systematically following the conventions of the Indonesian language.

To tackle these concerns, the learning process of scientific article writing skills using blended learning is required, which has been proven to be highly effective [7, 8], thus enhancing students' initiative and creativity in language learning [9]. Moreover, the blended learning method can also overcome students' difficulties in developing ideas [1] that will be expressed in the form of scientific article writing, as evidenced in EFL learning [10]. Therefore, it can improve student performance [11]. Furthermore, students can access learning materials anywhere and anytime according to their needs using the internet network [12]. The process of learning transcends spatial and temporal constraints for both students and lecturers to carry out an optimal learning process. Students can freely access lecture features using the widespread internet network. Additionally, considering its practicality, the development of this learning model is highly suggested and practical for use in the future scientific article writing learning process [13−15].

Throughout this period, the process of learning scientific article writing has been implemented by utilizing e-learning and Microsoft Teams features. It is necessary to support this process using the blended learning method, where instructors adopt new technologies during classroom teaching [16]. In addition, instructors need to design learning in a creative, innovative manner that aligns with the students' culture [12]. This approach does not replace face-to-face or conventional learning methods [17−20] but provides a new platform for students by leveraging technology as a tool to enhance the learning process [21]. Blended learning represents a transformative model of learning that is highly beneficial for the future [22]. The application of blended learning has been widely adopted by teachers, lecturers, and practitioners as it has proven to positively contribute to the advancement of technology-enhanced education [12]. Previous research indicates that blended learning has an impact on ESL/EFL learning [10]. Therefore, educators need to persist in acquiring expertise in technology to stay informed and appropriately integrate language learning approaches, models, strategies, techniques, and methods. Cerna [9] adds that instructors can develop new content and learning materials based on experiences gained through face-to-face interactions with students.

Furthermore, to enhance students' creative thinking abilities in writing scientific articles, Creative Problem Solving (CPS) is required. CPS is designed as an innovative solution for students to address challenges in writing scientific articles, encouraging them to generate more creative ideas and concepts [23]. The problems addressed by students involve contemporary and specific issues. CPS enables students to think creatively and solve problems [24]. However, students encounter challenges during the activity of writing scientific articles, including providing ideas that are irrelevant to the problem (fluency aspect), making errors in identifying problems and facts (flexibility aspect), producing scientific articles that do not express new insights (novelty aspect), and developing ideas that lack detail (elaboration aspect).

Moreover, the learning process using integrated blended learning and CPS has proven to be highly effective in scientific article writing skills [7, 8], particularly during the COVID-19 pandemic [25]. This approach enhances students' initiative, motivation, and creativity in language learning [26, 27]. Moreover, the blended learning method can address students' difficulties in developing ideas for scientific articles [1]. Students can access Android-based learning features anywhere and anytime as needed using the internet [12, 28] and conduct lectures using e-learning. Considering its practicality, the development of this learning model is highly suggested and practical for use in scientific article writing learning [29].

Based on the issues mentioned, a learning model is needed to enhance students' interest in writing and publishing scientific articles [15, 30, 31], and to engage students in reading [29]. This study aims to explain the development process of the BROSING model (bibliographic exploration, research synthesis, objective examination, study analysis, idea generation, narrative development, and goal-driven publishing) and to assess the validity, practicality, and effectiveness of this model. The BROSING model addresses several challenges encountered by students in academic writing, providing a structured approach to scientific article writing while enhancing creativity and critical thinking skills. Students often face difficulties in topic identification, idea generation, and the systematic development of scientific articles, along with adhering to language rules and writing structure. However, the BROSING model offers a comprehensive solution by guiding students through stages.

The previous study by Budjalemba and Listyani [32] examined why students find academic writing challenging. In contrast, this current study aims to create and test a new model for teaching scientific writing. Rather than solely investigating the difficulties, this study seeks to address the problem by providing students with a structured learning approach.

The research is expected to generate innovative and creative learning models. This study is supported by a digitally-based campus, producing innovations and novel insights in examining the development of a learning model for scientific article writing based on blended learning incorporated with CPS. The ultimate goal is to enhance students' Creative Thinking Skills (CTS), and the outcomes will manifest in the form of model books, lecturer books, and student books. Ultimately, this study aims to address the research question: Is the developed BROSING model valid, practical, and effective?

II. Literature Review

A. Integrated Blended Learning

Blended learning, hailed as a remedy for the shortcomings of online learning, effectively integrates online, offline, and face-to-face instructional methods [33, 34]. Unlike online learning, which relies on media with user-controlled tools, offline materials in blended learning lack such features and do not necessitate internet connectivity, exemplified by tutorial materials stored in offline applications. Blended learning harnesses various educational tools, including real-time software and online web-based learning platforms, to enhance learning environments and knowledge management systems. Moreover, this pedagogical approach, as presented by Almazova *et al.* [35], stands as a cornerstone for successfully implementing integrated learning strategies. Rooted in the theoretical framework of adult learning, it underscores the practical application of newly acquired knowledge to past experiences and advocates for lifelong learning [36, 37]. Environmental factors, such as system functionality and content features, exert significant influence on the efficacy of blended learning [38, 39]. To optimize its effectiveness, it is advisable to provide technology-related training sessions prior to implementing blended learning and to cultivate a sense of community through interactive online engagements. Such measures can enhance learners' computer self-efficacy and communication skills.

In conjunction with its adaptability, blended learning combines traditional face-to-face instruction with technology-mediated activities, offering students the flexibility to engage with course materials and interact with peers and instructors across physical and virtual learning environments [40]. While providing personalized learning experiences and facilitating real-time assessment of student progress, effective implementation of blended learning relies on careful planning and coordination to accommodate the diverse needs of all learners. With three primary models—skill-driven, competency-driven, and attitude-driven—blended learning has gained traction in universities over the past three decades, emerging as a viable alternative to traditional teaching methods [34]. Its widespread adoption, particularly in higher education, is underscored by its adaptability and convenience for students.

B. Creative Problem Solving

CPS is a learning model that focuses on teaching problem-solving skills, followed by skill reinforcement [41]. When faced with a question, students can use problem-solving skills to select and develop their responses. Instead of merely memorizing without thinking, problem-solving skills expand the thinking process. The process of the CPS learning model consists of problem clarification, opinion expression, evaluation and selection, and implementation [42]. CPS in addressing issues means employing any means of creative thinking to creatively solve a problem.

In its implementation, CPS is carried out through creative solutions. CPS is built on three important components: perseverance, problems, and challenges [43]. CPS aims to develop divergent thinking, striving to achieve various

alternatives in solving a problem. Moreover, in its implementation, it primarily places educators as facilitators, motivators, and learning dynamics both individually and in groups [44]. The CPS learning model is an approach that focuses on teaching and problem-solving skills, followed by skill reinforcement. With this approach, it is hoped that when faced with a problem, students can employ problem-solving skills and develop their ideas. This is done not only by memorizing without thinking, but rather by focusing on understanding and problem-solving skills, thus expanding the thinking process [43].

C. Creative Thinking Skills

Creative thinking involves the ability to construct or generate various possible responses, ideas, or alternatives to a problem or creative challenge [45]. This includes four key components: fluency, flexibility, originality, and elaboration [46]. Fluency refers to the capacity to provide accurate responses to mathematical problems, while flexibility entails answering mathematical problems in non-traditional ways. Originality involves the ability to tackle mathematical problems using one's unique language, methods, or ideas. Elaboration refers to expanding problem answers, introducing new problems, or generating new ideas.

Additionally, creative thinking is a cognitive process that leads to the production of creative products [47]. It is a thinking process that generates diverse possibilities of answers when responding to given problems. This indicates that creative thinking is grounded in deep conceptual understanding. Overall, creative thinking is essential for approaching problems innovatively and producing novel solutions.

D. Learning Models in Writing Pedagogy

Hasbullah *et al.* [48] discovered that the Multiple Intelligence Learning Approaches (MILA) effectively enhance students' English writing skills. The MILA encompasses interactive, analytic, and introspective domains, incorporating various elements such as linguistics, mathematics, visual, kinesthetic, music, intra-personal, interpersonal, naturalistic, and existential or spiritual aspects [49]. These elements are strategically integrated to elevate students' proficiency in English writing.

In a complementary vein, David and Anderson [50] introduced a novel instructional model known as the universal genre sphere, aimed at teaching academic writing in a manner suitable for all learners, with a particular focus on addressing the needs of English as additional language students, regardless of whether they have diagnosed learning differences. The proposed universal genre sphere model is grounded in universal design for learning principles and the tenets of the genre-based approach, particularly the teaching-learning cycle. By incorporating inclusive design elements and breaking down learning into manageable and adaptable segments, the universal genre sphere promotes greater accessibility to academic writing for a broader range of learners. The integration of universal design for learning and the genre-based approach presents an opportunity to revolutionize second-language writing instruction, aligning with the principles of inclusive education by reducing classroom barriers and offering students multiple pathways to engagement.

Additionally, Liu *et al.* [51] proposed a learning approach that combines Automatic Writing Evaluation (AWE) and Peer Assessment (PA) within the framework of the knowledge-building theory. This approach aims to enhance learners' reflection on AWE feedback through PA, thereby improving their EFL writing performance. The study revealed positive outcomes in writing performance, learning motivation, critical thinking, and reduced EFL writing anxiety. Furthermore, each approach was shown to offer distinct benefits and contribute to learners' understanding of the learning process.

The present study introduces a novel model for teaching scientific writing. Unlike previous learning models, this one is specifically tailored to focus on the composition of scientific articles. Termed the BROSING model, it comprises seven distinct phases: *b*ibliographic exploration, *r*esearch synthesis, *o*bjective examination, *s*tudy analysis, *i*dea generation, *n*arrative development, and *g*oal-driven publishing. Fig. 1 illustrates the model along with the creative process applied in each stage.

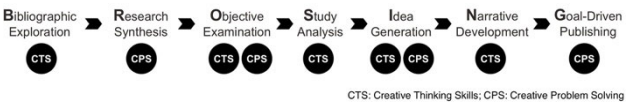

Fig. 1. BROSING model.

In the bibliographic exploration phase, students are guided to read various references, including textbooks, journals, proceedings, books, blogs, and websites. This phase applies CTS to identify unique angles or perspectives from diverse sources. The goal is for students to be able to summarize and find topics, titles, and a systematic approach to writing effective and correct scientific articles. Reading references is intended to provide understanding and knowledge to students.

During the research synthesis, students engage in analyzing the references obtained from publications. This stage utilizes CPS to navigate through various research findings and organize them cohesively. The goal of this synthesis is to obtain summaries and the structure for writing scientific articles according to the topics guided by the instructor. In this activity, students are directed to access Google Scholar and respected international journals as reference sources. Students may face difficulties when accessing international journals due to the need for translation from English to Indonesian. However, this challenge should not hinder students from generating scientific articles during the research process, as they will receive guidance from the instructor on accessing journals and translating them.

The third activity is objective examination, conducted to acquire facts, concepts, scientific principles, and writing procedures that can be verified. This observational activity serves as a foundation for students to produce scientific articles. During this stage, CPS approaches are utilized to verify facts and CTS to understand scientific principles, and connect disparate pieces of information.

In the fourth activity, the study analysis is implemented, highly relevant to the observation activities previously conducted by students for the analysis of Indonesian language errors. At this stage, CTS are applied to brainstorm ideas, challenge assumptions, and explore alternative perspectives during group discussions. During this stage, students

participate in group discussions, exchanging opinions and interacting with their peers. Guided by the facilitator, students engage in group discussions and presentations on academic topics, presenting the outcomes of their discussions within their respective groups. They attentively listen to and engage with their peers' presentations, asking questions, challenging points, and providing diverse answers to raised questions. Ample time is allocated for comprehensive discussions to gather input from fellow class members.

During the idea generation stage, students receive guidance on how to write academic articles according to scientific principles and practical methods during both face-to-face and online lectures. In this stage, students engage in divergent CTS to generate multiple ideas, using CPS to overcome writer's block or develop innovative approaches to writing. Lecturers provide instructions in the physical classroom, or they reach students attending online classes via Microsoft Teams or other conference platform. Employing this blended learning method supports the creativity of students, particularly in the context of learning academic article writing [52].

During the narrative development stage, students individually undertake the process of writing academic articles, adhering to guidelines established based on previous observations and case studies. This stage involves applying CTS to craft engaging narratives, experiment with different writing styles, and incorporate unique perspectives into the article. Students compose academic articles, encompassing components such as the title, abstract, introduction, methodology, results and discussion, conclusion, and references [53], preparing them for publication in journals or seminar proceedings. In this phase, the instructor assumes the role of a reviewer, evaluating the article before its submission to a journal.

In the goal-driven publishing stage, once students have completed writing their academic articles following the prescribed structure, the next step involves publishing these articles in both national journals and international seminar proceedings. During this stage, CPS is used to address reviewer comments, refine articles for publication, and strategize for the successful dissemination of research findings. The publication requirements dictate adherence to the specified writing structure and a maximum plagiarism check score of 20%. If students successfully publish their work in national journals or SINTA-accredited national journals (Indonesia region), they receive additional assessment points.

III. Method

A. Research Design and Procedure

The research falls under the category of Research and Development (R and D), adhering to the principles of the Plomp development model. This study adopts a model as proposed by Plomp and Nieveen [54], as depicted in Fig. 2. In the initial stage, researchers examine the curriculum and analyze students' requirements for creative problem-solving and creative thinking skills. Subsequently, prototype products are created, such as a model book for teachers and books for students, alongside an e-learning platform for blended learning. These prototypes undergo continuous enhancement based on feedback from experts. In the concluding phase, experts evaluate the products to ensure their validity and practicality. Moreover, students provide feedback on the effectiveness of the learning process, offering insights into their perceptions of the various components involved.

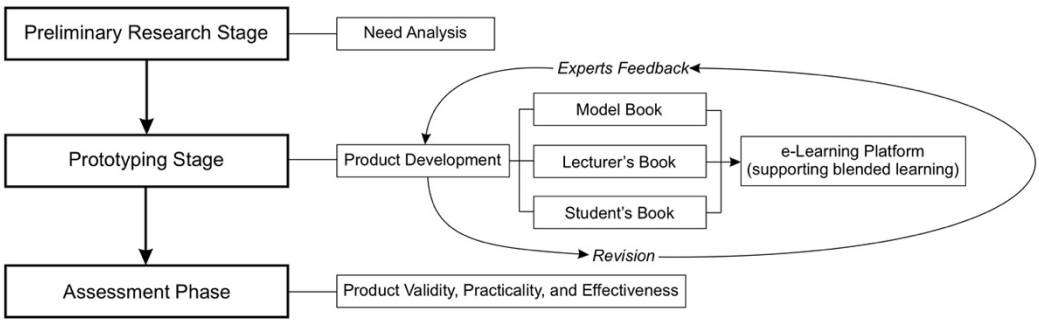

Fig. 2. The development process of the BROSING model.

B. Participants

In this research, the random sampling technique is employed for the selection of student research subjects, while purposive sampling is used for selecting experts. The population of the test subjects, or students, consists of all students at Universitas Putera Batam in the odd semester (2021/2022). Through random sampling, an experimental class comprising 26 students is selected from the Department of State Administration, while a control class consisting of 29 students is chosen from the Department of English Literature.

Meanwhile, the criteria for purposive sampling used to involve experts in this research include validators from the fields of education and technology. For education, the criteria involve individuals with a minimum of ten years of experience in the education field, while for technology experts, it includes someone who has worked in informatics for at least five years and is an expert in web development languages such as HTML, CSS, and JavaScript. Additionally, they should be proficient in UI and UX design and have an understanding of Content Management (CMS). Three education experts and one technology expert were obtained.

C. Learning Objectives

The learning process adopts a blended approach, combining both online and offline modalities across 16 sessions. Offline sessions are scheduled for the 1st, 3rd, 5th, 7th, 8th, 9th, 11th, 13th, 15th, and 16th meetings, while online sessions are designated for the 2nd, 4th, 6th, 10th, 12th, and 14th meetings, each spanning 100 minutes. By the end of this

blended learning experience, the primary objective is for students to produce an article addressing errors in Indonesian language usage found in theses, journals, banners, official letters, and print or online media, or to explore public service issues in their local context. The sequential objectives for each session are outlined as follows: meetings 1 and 2 focus on students sourcing references from e-journals, e-proceedings, e-books, and websites. Subsequent sessions (3 and 4) involve reviewing and reporting findings from gathered references to the lecturer, aiming to equip students with the necessary writing standards for journal publication. Meeting 5 empowers students to autonomously select topics based on their observations of language errors or public service issues. Meeting 6 tasks students with a case study assignment, requiring them to draft a concise research proposal on their chosen topic, to be evaluated by the lecturer and submitted via Microsoft Teams Assignment prior to the subsequent session. Meeting 7 aims to enrich students with supplementary information supporting their chosen topics, bolstered by feedback from previous assignments. By meeting 8, students are expected to select a national-level journal relevant to their research scope and commence article writing according to the journal's guidelines, alongside learning to utilize citation software such as Mendeley, Zotero, or EndNote. Emphasis in this session lies on understanding journal guidelines and writing conventions. Students are then tasked with submitting their written work before the next session. Meetings 9, 10, and 11 build upon previous sessions, focusing on refining writing based on lecturer feedback. Meetings 12 and 13 involve peer presentations of written work to the entire class. In meeting 14, students begin the submission process to their chosen journals. Meeting 15 requires students to document their journey from initial idea generation to article submission, including supplementary documents like similarity reports and lecturer corrections. Meeting 16 concludes with the assessment of final task outcomes, with the lecturer evaluating the strengths and weaknesses of students' articles in the final submitted journal version.

D. Data Collection and Analysis

The model's validity and practicality process involves selected experts. This process includes qualitative analysis by seeking considerations and improvement suggestions from experts regarding the instrument text used. Quantitative analysis is conducted to test the instrument's feasibility, which can be measured through content validity. Face validity is examined based on the instrument's appearance format, and logical validity is obtained through checking the instrument's item to conclude that the instrument measures relevant aspects. This is achieved by creating a specification table describing what is measured [55]. Subsequently, the validation scores of the research instrument are converted into quantitative criteria.

Additionally, effectiveness testing was conducted on the sample, namely students, through questionnaire completion. The validity, practicality, and effectiveness categories adopted were based on Riduwan's classification [56]. For validity, the categories are as follows: 81−100%: highly valid, 61−80%: valid, 41−60%: moderately valid, 21−40%: less valid, and 0−20%: invalid. Similarly, the practicality categories follow Riduwan's [56] classification: 81−100%: highly practical, 61-80%: practical, 41−60%: moderately practical, 21−40%: less practical, and 0−20%: not practical. As for effectiveness, Riduwan's [56] classification includes: 81−100%: highly effective, 61−80%: effective, 41−60%: moderately effective, 21−40%: less effective, and 0−20%: not effective.

Meanwhile, data analysis techniques involve statistical data from the validity test, practicality test, and effectiveness test results on the model book, lecturer book, and student book. Furthermore, tests for normality, homogeneity, and hypothesis testing are conducted on the trial product subjects to address hypotheses.

IV. Results

A. Preliminary Research

In this research, curriculum needs analysis is conducted in the context of research or instructional model development to ensure that the proposed teaching approach or developed model is truly relevant to the specific needs of students and the existing educational context. While the curriculum is indeed mandated by the Ministry of Education, each program of study or institution has its own unique characteristics and challenges in terms of learning and teaching.

The results of the analysis of the curriculum components' needs are presented in Table 1. The highest score is obtained by the textbook, amounting to 90%, indicating that this component is highly needed. Other components, such as the semester lesson plan, fall into the category of highly needed with a score of 84%. Meanwhile, other components score 80%, including the course learning outcomes, graduate learning outcomes, handouts, and the model for writing scientific articles, categorized as needed.

Table 1. Results of curriculum need analysis

Component	Cumulative Value	Decision
Semester Lesson Plan	84%	Highly Needed
Course Learning Outcomes	80%	Needed
Graduate Learning Outcomes	80%	Needed
Handouts	80%	Needed
Textbook	90%	Highly Needed
Model for Writing Scientific Articles	80%	Needed

Furthermore, an analysis of the needs for students' CTS was also conducted as a foundation for model development. This analysis involved 55 students at Universitas Putera Batam in the third semester (2021/2022) using a survey with Yes or No questions. For example, in item 1: "Do you feel you have sufficient flexibility in your thinking to adapt to various situations and challenges?" and item 2: "Are you able to generate a large number of ideas or solutions to a given problem quickly and easily?"

Table 2 presents the results of this needs analysis, which is the cumulative value obtained in the percentage of "No" answers. The highest score is obtained for the aspect of flexibility with a value of 90.51%. Subsequently, the following scores are obtained for the aspects of novelty, fluency, and detail with values of 87.30%, 85.76%, and 85.38%, respectively. These findings from the needs analysis suggest that the next step, the prototype development of the product, can proceed.

Table 2. Analysis of students' needs in CPS and CTS

Aspect	Cumulative Value	Decision
Flexibility	90.51%	Highly Needed
Fluency	85.76%	Highly Needed
Novelty	87.30%	Highly Needed
Detail	85.38%	Highly Needed

B. Development of Product Prototype

1) Design of model book, lecturer's book, and student's book

The designed products consist of a model book, a lecturer book, and a student book. These three products serve as materials for implementing the BROSING model, which includes bibliographic exploration, research synthesis, objective examination, study analysis, idea generation, narrative development, and goal-driven publishing. The BROSING model is a blended learning-based scientific article writing instruction that focuses on CTS.

The design of the model book includes an introduction, theoretical and philosophical foundations, syntax, support systems, social systems, reaction principles, instructional impact, and accompanying impact, along with implementation instructions for the BROSING model. Additionally, the lecturer's book provides guidance and outlines the implementation process of learning to write scientific articles based on the curriculum and semester learning plans for the general Indonesian language course in higher education during the third semester. The lecturer's book comes with assessment tools to achieve learning objectives and enhance students' creative thinking abilities. Furthermore, the student's book covers the introduction and the implementation process of the BROSING model in both online and offline scientific article writing learning. Fig. 3 displays the contents of the lecturer's book, which outlines the guidelines for implementing the BROSING model and provides detailed information on implementation for each session.

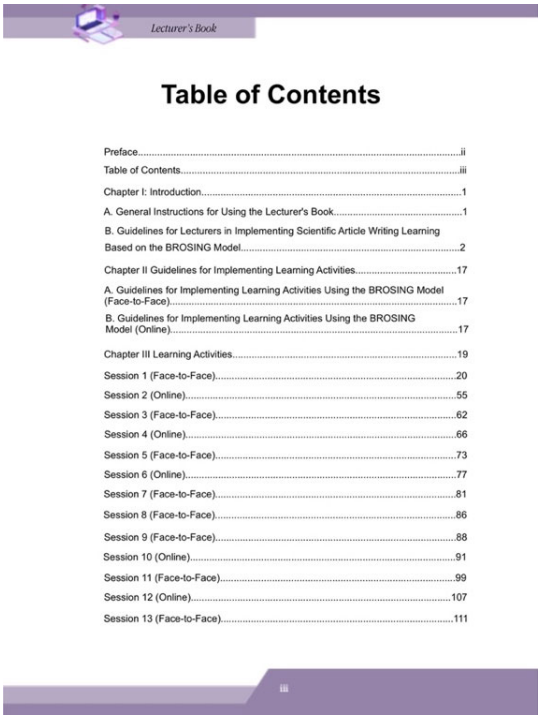

Fig. 3. Contents of the lecturer's book of the BROSING model.

In addition to being supported by model book, lecturer book, and student book, this model is also backed by a platform in accordance with the three books, accessible to both lecturers and students at modelBROSING.com (Fig. 4). This platform, which is supported for online learning sessions, contains material from developed books. Students and lecturers have different access roles, as students can only access student learning material. Meanwhile, Fig. 5 shows the content for Session 1, which is compiled from the lecturer's book. It contains learning objectives, learning activities, as well as learning material.

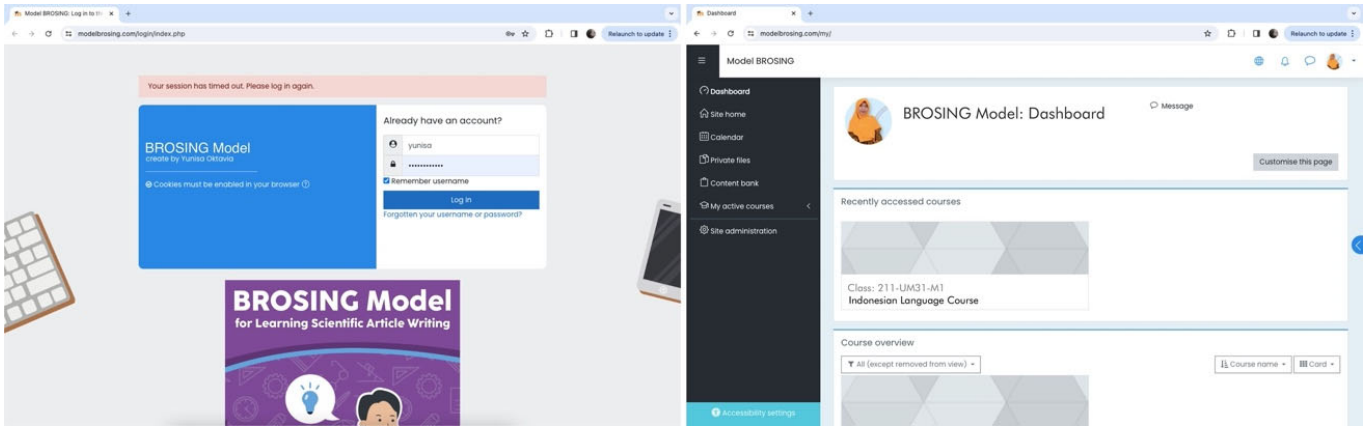

Fig. 4. Preview of the e-learning platform: login page (left) and dashboard home (right).

2) Formative evaluation

Formative evaluation aims to obtain feedback and improvement suggestions for the products produced from the model book, lecturer book, and student book. Formative evaluation activities consist of two parts: (a) self-evaluation, where the lack of cohesion and coherence in sentence and paragraph writing in the model book is identified, and (b) expert review, conducted by validators to gather feedback and suggestions for improving the produced products.

3) Revision stage

Revision activities are carried out after receiving feedback from validators, including experts in design, practitioners in academic writing, experts in Indonesian language teaching, and experts in product. This revision process is repeated several times until the predetermined validity scores are achieved.

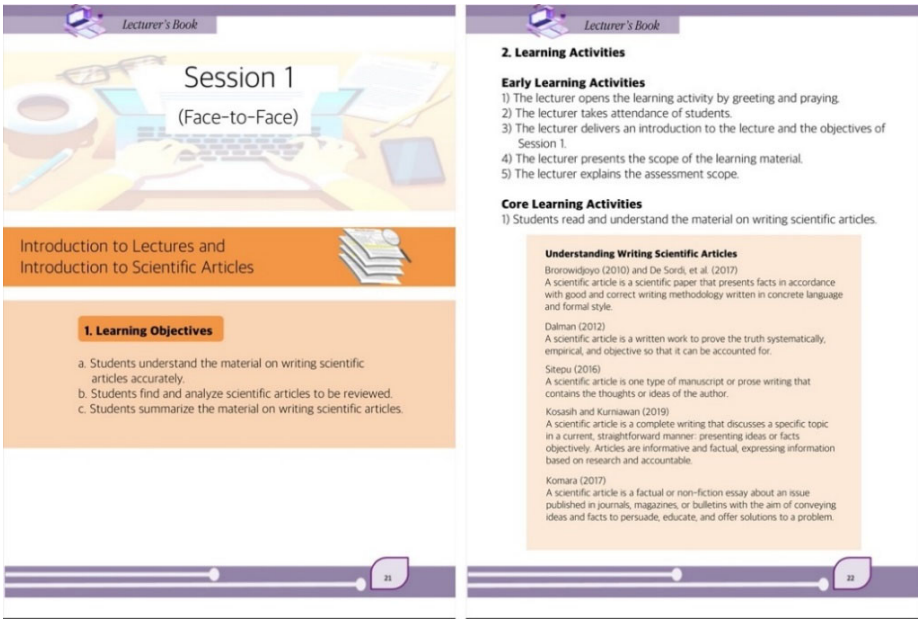

Fig. 5. Preview of the content of session 1.

C. Product Assessment Results

1) Validity test

Table 3 presents the findings of the validity test for the three produced products. The validation scores for the model book, lecturer book, and student book are 89.44%, 94.44%, and 91.67%, respectively, all categorized as highly valid.

Table 3. Validity testing results

Product	Validator				Cumulative Value	Decision
	1	2	3	4		
Model Book	88.00%	90.67%	92.00%	87.10%	89.44 %	Highly Valid
Lecturer's Book	89.33%	92.00%	98.67%	977.77%	94.44%	Highly Valid
Student's Book	80.00%	93.33%	96.00%	97.33%	91.67%	Highly Valid

2) Practicality test

The practicality test results in Table 4 indicate average scores of 85.00% for the model book, 85.71% for the lecturer's book, and 87.27% for the student's book, categorizing them as highly practical.

Table 4. Practicality testing results

Product	Validator				Cumulative Value	Decision
	1	2	3	4		
Model Book	84.00%	88.00%	88.00%	80.00%	85.00%	Highly Practical
Lecturer's Book	84.00%	85.33%	88.00%	85.52%	85.71%	Highly Practical
Student's Book	88.00%	86.67%	86.67%	87.74%	87.27%	Highly Practical

3) Effectiveness test

Student self-assessment was only conducted with experimental classes to assess model effectiveness. The findings of the product effectiveness test in Table 5, conducted using this questionnaire, reveal cumulative scores of 88.97% for blended learning, 88.58% for scientific article writing, 87.40% for CPS, and 87.23% for CTS. These results categorize the product as highly effective for all components.

Table 5. Effectiveness testing results

Component	Cumulative Value	Decision
Blended Learning	88.97%	Highly Effective
Scientific Article Writing	88.58%	Highly Effective
Creative Problem Solving	87.40%	Highly Effective
Creative Thinking Skills	87.23%	Highly Effective

D. Model Impact

In this stage, an analysis was conducted to address the influence of the model's use in learning. The data used consisted of students' scientific writing skills assessed by lecturers based on the students' final product writing. The assessment rubric used has a maximum score of 100, with the following breakdown: clarity of the scientific article's title and author identification scores 10; introduction section scores 22; theoretical framework section scores 10; methodology section scores 3; discussion section (relevance to previous studies and inclusion of a minimum of five relevant citations) scores 15; conclusion section scores 5; reference list section (using citation software and a minimum of 10 references) scores 5; writing structure scores 10; and other factors including language fluency, adherence to language norms, page count, timeliness of assignment submission, and clarity in expressing ideas score a total of 20.

The proposed hypothesis in this study is that there is a significant difference in students' scientific article writing skills between those taught in BROSING model classes and conventional classes. Before addressing the hypotheses, prerequisite tests, including tests for normality and homogeneity, need to be performed. Tables 6 and 7 present the outcomes of the normality test conducted using the Shapiro-Wilk test in the experimental and control classes, respectively. From Table 6, L_{ob} represents the observed value of a specific Lielifors test statistic, calculated to be 0.17137. Additionally, L_{cv} denotes the critical value of the Lielifors test statistic at a significance level (α) of 0.05, determined to be 0.173. Thus, since $L_{ob} < L_{cv}$, it can be inferred that the data follows a normal distribution.

Table 6. Results of normality test in the experimental class (taught using the BROSING model)

Xi	Fi	$Xi - \bar{x}$	$Fi.Xi$	$Fi.Xi^2$	Fk	Zi	$F(Zi)$	$S(Zi)$	$\lvert F(Zi) - S(Zi) \rvert$
70	1	–12.88	70	4900	1	–1.9901	0.1093	0.0384	0.0708
75	4	–7.88	300	22500	5	–1.2175	0.2266	0.1923	0.03429
80	7	–2.88	560	44800	12	–0.4450	0.3936	0.4615	0.06793
85	7	2.12	595	50575	19	0.3275	0.5793	0.7307	0.15146
90	5	7.12	450	40500	24	1.1001	0.7517	0.9230	0.17137
95	2	12.12	190	18050	26	1.8727	0.887	1	0.113
Total	26	-	2165	181325	-	-	-	-	-

[1] Xi: Value of the variable; Fi: Frequency of occurrence of each value; $Xi - \bar{x}$: Deviation of each value from the mean ($\bar{x}$); $Fi.Xi$: Product of frequency (Fi) and value (Xi); $Fi.Xi^2$: Product of frequency (Fi) and the squared value (Xi^2); Fk: Cumulative frequency; Zi: Standardized score (Z-score) calculated for each value; $F(Zi)$: Cumulative probability corresponding to the Z-score; $S(Zi)$: Expected cumulative probability under the standard normal distribution; $\lvert F(Zi) - S(Zi) \rvert$: Absolute difference between the observed and expected cumulative probabilities.

Table 7. Results of normality test in the control class

Xi	Fi	$Xi - \bar{x}$	$Fi.Xi$	$Fi.Xi^2$	Fk	Zi	$F(Zi)$	$S(Zi)$	$\lvert F(Zi) - S(Zi) \rvert$
60	2	–14.137	120	7200	2	–0.673	0,2514	0.09523	0.156161905
65	4	–9.1379	260	16900	6	–0.4351	0,3336	0.28571	0.047885714
70	4	–4.1379	280	19600	8	–0.1970	0,4247	0.38095	0.043747619
75	6	0.8620	450	33750	10	0.0410	0,516	0.47619	0.039809524
78	5	3.8620	390	30420	14	0.1839	0,5714	0.66666	–0.095266667
80	6	5.8620	480	38400	20	0.2791	0,6064	0.95238	–0.345980952
85	2	10.8620	170	14450	21	0.5172	0,615	1	–0.385
Total	29	-	2150	160720	-	-	-	-	-

From Table 7, it is obtained that L_{ob} = 0.156, while L_{cv} at a significance level of α (0.05) = 0.161. Therefore, since $L_{ob} < L_{cv}$, a conclusion can be drawn that the data follows a normal distribution. Additionally, Table 8 shows the results of the homogeneity test on the scores of scientific article writing skills from both classes. Based on these results, it can be obtained that F_{ob} = 1.128, while F_{cv} = 1.932 at a significance level of α = 0.05. The conclusion can be made that the variances of the data are homogeneous, as indicated by $F_{ob} < F_{cv}$. Since both prerequisite tests have been met, namely normal and homogeneous data, hypothesis testing can be performed using the t-test.

The hypothesis test to ascertain if there is a significant difference in article writing skills between the experimental and control classes is performed using the t-test. The t-test results are presented in Table 9, where t_{ob} = 5.055, while t_{cv} = 1.674 at a significant level of α = 0.05 with degrees of freedom (df) = 63. The null hypothesis (H0), which posits that there is no significant difference in students' scientific article writing skills between those taught in BROSING model classes and conventional classes, is rejected, as t_{ob} exceeds t_{cv}. Consequently, it can be inferred that a significant difference exists between the experimental and control classes in the test. In other words, students taught using the BROSING model achieve higher proficiency in article writing skills.

Table 8. Results of homogeneity test using F-test (two-sample for variances) on the scientific article writing skills test

Parameter	Mean	Variance	Observations	df	F	P (F ≤ f) one-tail	F Critical one-tail
Control Class	74.13793103	47.26600985	29	28	1.128481411	0.382136683	1.932294679
Experimental Class	83.26923077	41.88461538	26	25			

Table 9. Results of hypothesis testing results using t-test (two-sample assuming equal variances)

Parameter	Mean	Variance	Observations	Pooled Variance	Hypothesized Mean Difference	df	t Stat	P(T ≤ t) one-tail	t Critical one-tail	P(T ≤ t) two-tail	t Critical two-tail
Control Class	83.26923077	41.88461538	26	44.72761624	0	53	5.055324644	2.73196E−06	1.674116237	5.46391E−06	2.005745995
Experimental Class	74.13793103	47.26600985	29								

Table 10. Output of student scientific article publications after the implementation of the BROSING model

References	Article Link	Month of Publication
[57]	https://doi.org/10.37296/esci.v2i1.19	December 2021
[58]	https://doi.org/10.37296/esci.v2i1.20	December 2021
[59]	https://doi.org/10.53565/nivedana.v2i2.324	December 2021
[60]	https://doi.org/10.58218/alinea.v2i1.172	April 2022
[61]	https://doi.org/10.37296/esci.v2i2.21	May 2022
[62]	https://doi.org/10.25299/jiap.2022.vol8(2).9848	August 2022
[63]	http://dx.doi.org/10.31506/jipags.v6i2.15997	August 2022
[64]	https://doi.org/10.56552/jisipol.v4i1.87	October 2022
[65]	https://administrasistisip.ejournal.web.id/index.php/administrasistisip/article/view/310	October 2022
[66]	https://doi.org/10.30996/uncollcs.v1i.1238	December 2022
[67]	http://dx.doi.org/10.46730/jiana.v20i3.8034	December 2022
[68]	https://doi.org/10.56552/jisipol.v4i2.85	February 2023

E. Learning Output

Table 10 provides a list of academic articles already published by students, serving as tangible outputs from the task of writing academic articles based on the BROSING model. These publications not only showcase the students'

mastery of scientific article writing skills but also underscore their ability to effectively apply the principles and techniques taught within the framework of the BROSING model. In addition, these published articles make substantive contributions to the broader academic community by disseminating new insights, research findings, and perspectives on various topics.

V. Discussion

This research successfully achieved its research goal, which is the development of a model to support students in writing scientific articles. Previous research has also shown the positive effect of learning model on student writing skill. Argawati and Suryani [69] and Ilham [70] showed that learning model, specifically project-based learning can help students write well. In addition, similar to BROSING model developed in the present study, Maulida *et al.* [71] signified the importance for blended learning model in improving students' writing skills.

Several products have been tested to support BROSING model, including model, lecturer, and student books, as well as an e-learning platform to support the hybrid learning process. Examining the traits or features of the scientific article writing learning model serves as a reference for developing the scientific article writing learning model. In connection with this, the research location is known as the "digital campus," aligning with the streamlining of campus facilities to support blended learning-based scientific article writing. This includes the provision of 24-hour Wi-Fi networks, the utilization of *Microsoft Teams* accounts, the presence of e-learning resources at elearning.upbatam.ac.id, and a freely accessible repository at repository.upbatam.ac.id for students. These facilities are utilized throughout the scientific article writing learning process, integrating face-to-face and online learning [72]. However, the difference with the platform developed in this research, modelBROSING.com, is that this model is specific to teaching and scientific article writing projects.

The implementation of the BROSING model in the learning process has been tested, revealing a significant improvement in students' ability to write scientific articles after its implementation. Since this model is built on blended learning, it can also be stated that blended learning influences students' writing abilities [71, 73]. Maulida *et al.* [71] demonstrate that blended learning offers students a more interactive and engaging learning experience, and can also assist students in becoming more aware of their metacognitive processes during writing.

The learning output, in the form of article publications by students, also demonstrates the success of the BROSING model in teaching scientific article writing.

Perception plays a crucial role in the learning process of undergraduate students when it comes to article writing. Their perceptions significantly influence their attitudes, motivations, and strategies towards developing their writing skills [74, 75]. Positive perceptions can lead to greater engagement, motivation, and confidence in their writing abilities, ultimately fostering more effective learning outcomes. Therefore, nurturing positive perceptions towards writing is essential for promoting students' success in mastering article writing as undergraduates.

This study has successfully answered the research question as the developed model is deemed valid, practical, and effective. The findings reveal that the BROSING model, aimed at tackling challenges in scientific article writing and enhancing students' CTS, yielded positive outcomes. Validity tests conducted by experts indicated high validity percentages for the model book, lecturer's book, and student's book. Practicality tests categorized all components as highly practical. Additionally, effectiveness tests confirmed the model's efficacy in improving students' scientific article writing skills. These results collectively affirm the validity, practicality, and effectiveness of the BROSING model in enhancing students' proficiency in scientific article writing.

This study, while significant in its findings, is not without limitations. Firstly, the research was conducted within a specific educational setting, potentially limiting the generalizability of the results to broader contexts. Moreover, the focus on short-term outcomes, such as validity and practicality, may overlook the long-term effects of the BROSING model on students' academic writing skills and overall academic performance. Additionally, the study primarily emphasizes the positive aspects of the BROSING model, without thoroughly exploring potential challenges or areas for improvement.

VI. Conclusion

The research has effectively addressed the inquiry by establishing the validity, practicality, and effectiveness of the developed model. The development of the BROSING model and its implementation in teaching academic writing is yielding positive results, as evidenced by the validity testing of the model book, lecturer's book, and student's book, which all demonstrated high levels of validity and practicality. The components within this model are also indicative of efficiency for educational use. BROSING is conceptualized as an acronym representing bibliographic exploration, research synthesis, objective examination, study analysis, idea generation, narrative development, and goal-driven publishing. Each step has proven to generate publications that students can produce.

In the realm of future research endeavors, there is a notable recommendation to extend and broaden the evaluations of the BROSING model. These evaluations should be conducted across diverse educational settings and disciplines to comprehensively gauge the model's adaptability and effectiveness. Furthermore, delving into the long-term impact of BROSING on students' academic writing skills, publication productivity, and overall academic performance holds promise for illuminating valuable insights. Engaging in comparative studies with existing models or methods is advocated to discern the unique contributions and advantages offered by the BROSING model. Additionally, exploring students' perceptions and experiences with this innovative model is envisioned to enrich our understanding of its acceptability and usability.

Shifting focus to lecturers, it is imperative to emphasize the development of comprehensive training programs tailored to their needs. These programs should equip lecturers with the requisite skills and knowledge for the effective implementation of the BROSING model within academic

writing courses. An ongoing commitment to encourage continuous improvement in the model is highlighted. This involves fostering a collaborative environment where lecturers can openly share insights, address challenges, and exchange best practices related to the implementation of BROSING. Concurrently, supporting the creation of supplementary resources, such as video tutorials, will serve to augment the implementation of the model in various academic settings. Finally, the establishment of a robust feedback mechanism is strongly endorsed, providing a channel for insights from both lecturers and students.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

YO conceptualized the study, developed the methodology, and conducted the investigation; At developed the methodology, supervised the study, and carried out the visualization; MZ analyzed the data, provided software, and conducted project administration. All authors contributed to the writing of the manuscript draft and its revision. All authors have approved the final version.

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