International Journal of Education and Practice
2026 Vol. 14, No. 1, pp. 169-182
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v14i1.4693

Impact of learning portal web integration in collaborative writing on scientific writing ability, writing self-regulation, and writing self-efficacy

Evi Susanti[1]
Ade Hikmat[2+]
Wini Tarmini[3]

[1,2,3]*Department of Indonesian Language Education, Universitas Muhammadiyah Prof. Dr. Hamka, Indonesia.*
[1]*Email: evisusanti@uhamka.ac.id*
[2]*Email: ade_hikmat@uhamka.ac.id*
[3]*Email: winitarmini@uhamka.ac.id*

(+ Corresponding author)

Article History
Received: 25 June 2025
Revised: 27 October 2025
Accepted: 15 December 2025
Published: 12 January 2026

Keywords
Collaborative writing
Learning portal web
Self-regulation
Writing ability
Writing efficacy.

ABSTRACT

This study aims to examine the impact of integrating a learning web portal into collaborative writing education on scientific writing skills, writing self-regulation, and writing self-efficacy. This research employed a quasi-experimental method with 250 students from Kencana Vocational School, Bandung, Indonesia. Participants were divided into two groups: an experimental group and a control group. The experimental group received a learning web portal intervention, while the control group participated in face-to-face collaborative writing interventions. Data collection involved instruments such as a scientific writing performance evaluation scale, a self-regulation scale, and a writing self-efficacy scale. The study analyzed the types and extent of student writing mediation facilitated by the web. Data analysis utilized paired sample t-tests and one-way ANCOVA, complemented by thematic analysis of qualitative data. The results indicated that the use of a learning web portal significantly improved scientific writing skills, self-regulation, and writing self-efficacy compared to conventional collaborative writing interventions. Improvements in writing skills were observed across several components, including content, organization of ideas, and language use. Qualitative data analysis further reinforced that peer writing contributes substantially to these components. The study suggests that online media in collaborative writing learning can enhance students' writing quality by providing discussion spaces and feedback mechanisms. Additionally, integrating technology into language learning curricula is essential to strengthen its role in educational settings.

Contribution/Originality: The primary contribution and originality of this paper lie in the design of a learning portal website that aims to improve scientific writing skills, self-regulation, and scientific writing self-efficacy. This study documents the development of a learning portal that not only enhances scientific writing abilities but also addresses psychological factors involved in scientific writing, thereby providing a comprehensive approach to supporting learners in this domain.

1. INTRODUCTION

Current language learning has begun to optimize various methods and the latest technological media. Collaborative learning activities and the use of technology have been incorporated into various language skills learning (Cabero-Almenara & Meza-Cano, 2019; Nasim, Mohamed, Anwar, Ishtiaq, & Mujeeba, 2024). This collaborative language learning model optimizes student participation in various collaborative learning activities with more structure and direction. In addition, this learning model promotes a more prescriptive and clear role for teachers

in providing guidance for each student's collaborative activity (Ebadi & Rahimi, 2018; Kiziltaş & Kultas, 2025). Collaborative language learning is carried out based on Vygotsky (1978) social-constructivist theory. This theory focuses on students' collaborative activities with people who are more competent in providing guidance or assistance, both with teachers and peers. This collaborative writing encourages students to work together in compiling parts of a text in a structured manner and providing input to each other to improve the quality of writing (Wang, 2025; Žáková, Urbano, Cruz-Correia, Guzmán, & Matišák, 2025). Collaborative writing activities are centered on students to overcome the gap in writing skills between them. In the collaborative writing method, teachers must be able to play the role of guides and direct students as feedback providers to their peers. Additionally, students have more responsibility in collaborative writing and providing feedback to their classmates (Evenstein Sigalov & Konieczny, 2025).

The writing teaching model, in its implementation, optimizes the role of students. However, with the development of current learning technology, students are increasingly facilitated. Various online media have enabled students to learn to write collaboratively, including web media, Gen-AI technology, and other applications (Abedi et al., 2025; Ebrahimi & Ebadi, 2024). The use of web media that can be used for collaborative writing, including Web 2.0, wikis, and learning web portals. One of the web media suitable for teaching scientific writing collaboratively is the learning web portal media (Peungcharoenkun & Waluyo, 2023). This web media contains several web pages that can provide access to its users to collaborate in writing. The learning web portal media is also able to provide an environment for collaborative writing activities outside the classroom by providing opportunities for students to evaluate and improve their writing in separate places. Several previous studies have investigated collaborative writing using various web media, including Wiki, which has been shown to be effective in improving essay writing skills. Previous studies have shown that wikis, which have various features, such as discussion spaces and feedback, contribute significantly to improving essay writing quality. Furthermore, previous studies investigating Web 2.0 media have shown that these media can improve argumentative writing skills (Savarese et al., 2025; Zdravkova & Ilijoski, 2025). The contribution of both studies to the current study is that teaching design for writing skills using web media is very effective in improving students' writing skills due to the optimization of the use of features in the teaching design. Although some of the impacts of web media on students' writing skills have been studied, there are several aspects that have not been studied in previous research, such as collaborative activities, their impact on writing psychology, and their effectiveness on types of scientific papers.

Based on the explanation, the purpose of this study is to investigate the effectiveness of the integration of learning portal web media in collaborative writing skills on the quality of scientific papers in terms of content, writing organization, and language use. Referring to the theory, this study also investigates the types and frequency of student collaborative writing mediation through learning portal web media. This research additionally explores students' views and feelings regarding the interventions they have experienced. In writing abilities, there are psychological elements that can enhance writing skills, specifically self-regulation and self-efficacy in writing. These two psychological factors have been shown to enhance writing abilities according to multiple earlier studies (Erguvan, 2024; Huang & Pei, 2024). Numerous earlier studies have investigated the effects of internet usage on elements of self-regulation and writing self-efficacy (Cai & Enríquez Raído, 2025; Rentier, 2025). Nonetheless, earlier research has fallen short in addressing the specific role of learning portal websites and their effectiveness in enhancing students' scientific writing abilities. Thus, the originality of the current research lies in the application of an educational web platform, the integration of psychological elements of self-regulation and self-efficacy, and the emphasis on the types of academic writing produced by students. This research is expected to contribute to alternative uses of technology in education and the development of contributing psychological factors. Based on this explanation, it can be concluded that the purpose of this study is to investigate the impact of integrating learning portal web media in collaborative writing on students' scientific writing skills, self-regulation, and writing self-efficacy. The researchers formulated several research questions in this study, namely as follows:

a) How effective is the integration of learning portal web media in collaborative writing in improving scientific writing skills?
b) How effective is the integration of learning portal web media in collaborative writing in improving self-regulation and writing self-efficacy?

2. THEORETICAL REVIEW

This study is grounded in Vygotsky (1978) theory of social constructivism. According to this theory, students can develop their understanding through different collaborative tasks with classmates. This activity can facilitate students in increasing their knowledge through the zone of proximal development (ZPD).

2.1. Collaborative Writing Through Learning Web Portal Media

Collaborative writing activities and interactions between students during the writing process have been shown to contribute significantly to planning, generating ideas, organizing text structures, editing, and improving (Iyamuremye, Twagilimana, & Niyonzima, 2025; Selcuk, Jones, & Vonkova, 2019). In addition, this collaborative writing has also been shown to be effective in increasing students' creativity, critical thinking skills, and motivation in completing writing assignments. This collaborative writing method will be more optimal if facilitated by using web media, such as learning web portal media, wikis, webquests, blogs, and Google Docs (Ellahi et al., 2024; Jensen, 2018). These online media can facilitate students in carrying out collaborative writing activities without limitations, so that they are able to create effective writing activities, as well as compile and improve texts (Waer, 2021; Wang, Chang, Lin, & Chen, 2018). Web media learning portals become asynchronous web-based communication tools that provide students with access to write, access, and improve texts collaboratively. This web media also provides personalized writing learning for students because they can set their own writing speed and improve it. In addition, web media can also be a means for students to provide feedback to each other in order to improve the quality of their writing. Several previous studies have investigated the role of collaborative writing mediated by web learning portals, and the results of the studies found that web-mediated feedback can improve the quality of content, organization, and use of written language (Wang et al., 2018; Wang, 2019). Moreover, a different study revealed that online collaborative writing greatly influences the content and structure of students' essays (Jensen, 2018).

2.2. Self-Regulation in Writing

Self-regulation in writing encompasses the thoughts, feelings, and actions that a writer employs to improve their writing skills. Writing self-regulation involves the writer's ability to oversee cognitive and emotional processes to enhance students' writing abilities (Bustamante, 2019; Link, Mehrzad, & Rahimi, 2020). Furthermore, independently initiated tasks will require more effective self-regulation techniques in writing, which can significantly improve writing skills. Based on the social cognitive model of writing, writing self-regulation includes various aspects such as environmental, behavioral, and individual factors (Cabero-Almenara & Meza-Cano, 2019; Fathi & Rahimi, 2020). Environmental factors of writing self-regulation involve adjusting contexts to facilitate writing activities. Behavioral components of writing self-regulation involve the capability to oversee, assess, and articulate one's own writing. Personal factors in writing self-regulation pertain to the capacity to employ cognitive and emotional strategies when completing writing assignments (Alberth, 2019; Gánem-Gutiérrez & Gilmore, 2021). All of these aspects contribute to the quality of an individual's writing. Several previous studies have found that online social media applications affect writing self-regulation. Previous studies explored the impact of computer-based graphic organizers on argumentative writing skills (Beis, Harris, & Shreffler, 2019; Nasim et al., 2024). In the study, self-regulation strategies in computer-based applications also facilitated students in determining writing goals, exchanging ideas, organizing ideas, writing, and evaluating their own writing.

2.3. Writing Self-Efficacy

Writing self-efficacy relates to students' views of their writing abilities depending on the context. This confidence in writing improves writing skills. Self-efficacy in writing includes ideas, standards, and self-regulation (Kiziltaş & Kultas, 2025; Žáková et al., 2025). Ideas denote the capability to create concepts as the initial step in the writing process. Conventions refer to the skill of conveying thoughts through effective language use. Self-regulation involves skills for self-management, effective oversight of writing, and the capacity to evaluate cognitive and linguistic aspects during the writing process. Thus, writing self-efficacy has the potential to forecast and enhance writing self-regulation abilities. Self-efficacy can boost students' belief in employing self-regulation techniques in writing, which can ultimately enhance their writing abilities. Writing self-efficacy can be improved through the use of web media or other applications (Evenstein Sigalov & Konieczny, 2025; Yang & Stefaniak, 2025). Multiple past studies have demonstrated that social media can enhance writing abilities and self-confidence in writing, with Facebook serving as a tool that helps students communicate to improve their writing skills and self-efficacy. These social platforms have shown effectiveness in enhancing writing self-efficacy (Abedi et al., 2025; Alberth, 2019). Additionally, another research indicated that utilizing digital storytelling media in writing education can enhance writing self-efficacy. The research revealed that online storytelling enhances students' abilities in writing assessment and improvement (Beis et al., 2019; Nasim et al., 2024). The research indicates that web media and online applications play a crucial role in enhancing students' writing self-efficacy.

3. METHOD

3.1. Design and Participants

The method used in this study was a quasi-experimental design to investigate the impact of web portal learning media integration on scientific writing skills, self-regulation, and writing self-efficacy. The research involved a quasi-experiment with 250 students from Kencana Vocational School, Bandung, Indonesia. Both quantitative and qualitative data analyses were conducted to obtain comprehensive insights. Additionally, the study included the development of microgenetic writing and semi-structured interviews. The participants comprised 250 vocational high school students, with an equal distribution of females and males (125 each), aged 16-19 years. Participants were divided into two groups: an experimental group and a control group, each consisting of 125 students. The experimental group received collaborative writing instruction based on a learning portal web media, while the control group received conventional collaborative writing instruction. Both interventions lasted for one semester. Prior to the intervention, instructors or teachers were confirmed to have experience with online applications, and students were confirmed to have never participated in a specialized online writing class. Furthermore, a detailed explanation of the web-based collaborative writing portal was provided to students to ensure a comprehensive understanding of the intervention. The researcher also confirmed that all participants had similar levels of writing ability. A pretest was conducted using a writing ability test to assess initial differences between the two groups. An independent sample t-test was performed to examine differences in writing ability, and the results indicated no significant differences between the groups in their ability to write scientific papers.

3.2. Instruments

This research employed various tools, such as a language proficiency placement exam for students, a constrained-time writing skills assessment, a writing self-regulation questionnaire, a self-efficacy inventory, and a semi-structured interview.

3.2.1. Language Ability Level Test

The assessment of language proficiency was conducted using the placement test created by Allan (2004). This evaluation was conducted to assess the language proficiency level of students in the two groups. The assessment

consists of 250 questions that evaluate students' listening, grammar, vocabulary, and reading abilities. The results from the validity and reliability tests for this tool showed an overall reliability index of 0.84, with sub-section reliability indices ranging from 0.80 to 0.83. Based on the instrument validity test criteria, a Cronbach's Alpha value > 0.60 indicates that the instrument is valid and meets the research criteria.

3.2.2. Time-Limited Writing Test

To determine students' scientific writing skills, students were asked to complete a scientific writing assignment that lasted 50 minutes at both the pretest and posttest stages, with a predetermined topic. The topics of the scientific papers were limited to several fields, namely social sciences, natural sciences, and technology, according to their school majors.

3.2.3. Writing Self-Regulation Scale

Self-regulation was assessed using the self-regulation scale created by Han and Hiver (2018). The self-regulation writing scale consists of 10 items. This scale is used to assess students' methods in planning, organizing, and managing the goals and processes of writing their scientific papers. The self-regulation writing scale features a questionnaire that employs a 5-point Likert scale, with point 1 representing (strongly disagree) and point 5 denoting (strongly agree). The internal consistency of this self-regulation scale was assessed using Cronbach's alpha, which showed a value of 0.94 in this study. Based on the instrument validity test criteria, a Cronbach's alpha value > 0.60 indicates that the instrument is valid and meets the research criteria.

3.2.4. Writing Self-Efficacy Scale

The writing self-efficacy of students was evaluated using the writing self-efficacy scale developed by Han and Hiver (2018). This scale includes 8 items to assess individuals' beliefs and confidence in their writing skills. It is designed as a questionnaire featuring a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The reliability of the scale was evaluated using Cronbach's Alpha, which yielded a value of 0.85, indicating that the scale is suitable for the present study.

3.2.5. Semi-Structured Interviews

Semi-structured interviews were conducted individually with a sample of 20 students from the experimental group to investigate students' attitudes and perceptions of the intervention involving the integration of learning portal web media into the collaborative writing method. Student data were anonymized using identifiers (e.g., S1, S2) to maintain confidentiality. Each interview lasted approximately 30 minutes. Interviews were recorded and transcribed for analysis. The interview questions were tested for credibility using the examination technique from Creswell (2007) by verifying the accuracy of student responses. The interview results were further analyzed and shared with students for data accuracy verification and potential modifications if necessary.

3.3. Research Procedure

3.3.1. Intervention Of Collaborative Writing Based on Learning Portal Web Media

In the experimental group, the learning portal web was used to facilitate students in completing collaborative writing assignments. The first stage involved researchers and teachers providing a comprehensive explanation of the use of web media and introducing various features of the web, such as discussion forums, improvements, feedback, and storage. Additionally, teachers practiced its use directly. In the next stage, students were randomly divided into several groups consisting of 3-4 students. Each group worked together to complete the writing assignment, focusing on three aspects: content, organization, language use, depth of argumentation, and the final draft of the writing stored in the learning portal web. Each group received a different topic, including social sciences, natural sciences, and

technology. During the intervention, teachers activated the schemata owned by students with various materials accessible in the learning portal web. Students were given two weeks for the draft writing. The teacher observed the discussion forum/platform during the completion of the writing assignment and ensured that each student contributed to the group's work. In the final stage, when the draft was completed, the teacher provided more opportunities for peer review of the group's writing, especially on content, organization, and language use. This peer review encouraged students to discuss more intensively, evaluate, and improve their essays, leading to the completion of a revised draft.

3.3.2. Conventional Collaborative Writing Intervention

Students in the control group received a conventional or face-to-face collaborative writing intervention. All procedures in the experimental group were carried out in the control group only without using the learning portal web media. Students in the control group were given the same topic as the experimental group, and the assessment focused equally on aspects of content, organization, language use, and completion of the draft writing. A brainstorming session was conducted in the control group to reactivate the schema they had about the topic to be used. Each group in the control group consisted of 3-4 students. Each group was asked to complete the task of writing a scientific article within 2 weeks and submit it to the teacher. After the first draft was completed, the instructor mediated peer feedback directly in class on aspects of content, organization, and language use. After the discussion and feedback session, students were given the opportunity to revise their writing collaboratively again in class and submit a second draft to the instructor.

3.4. Data Collection

Data collection was conducted using several instruments described previously. Two scientific writing assignments at the pretest and posttest stages were used to obtain data on students' writing skills. The scientific writing assessment rubric for articles was adopted from Hartfiel and Hughey (1981). This rubric has a total value of 100, with each aspect assigned 25 points for content, 25 points for organization, 25 points for grammar, 15 points for vocabulary, and 10 points for writing mechanics. The writing assignments were assessed by two trained teachers to minimize research bias. The reliability of the assessment was evaluated using Cohen's Kappa inter-assessment reliability test. The Cohen's Kappa value was 0.84, indicating that the reliability among assessors met the evaluation standards. The results of the collaborative writing mediation in the experimental group were analyzed and categorized. Wertsch (1985) concept of microgenesis was utilized to identify students' self-regulation in improving their socio-cognitive aspects of writing in terms of content, structure, and language use. Additionally, individual semi-structured interviews were conducted to explore students' views and opinions regarding the intervention.

3.5. Data Analysis

This study employed the Kolmogorov-Smirnov test, paired sample t-test, and one-way ANCOVA to analyze the impact of integrating the learning portal web media. The paired sample t-test assessed the effects of two interventions on writing abilities, self-regulation, and writing self-efficacy. Further analysis to investigate differences between the two interventions was conducted using one-way ANCOVA.

The evaluation involved comparing writing ability scores, self-regulation scales, and self-efficacy scales between the two groups. Initial scores in writing skills, self-regulation, and self-efficacy served as covariates in the analysis of differences between groups. The Kolmogorov-Smirnov test was used to evaluate the normality of data for both groups. Parametric techniques such as paired sample t-tests and one-way ANCOVA were employed to analyze differences in proficiency between pretest and posttest phases of both groups. Additionally, Likert scale data collected on students' self-regulation and writing self-efficacy were analyzed using parametric tests, including t-tests and ANCOVA.

These tests are also applicable for the statistical examination of ordinal data. The attitude scale was converted into interval data, enabling the use of parametric tests for analysis. Based on the normality test results, the data exhibited a normal distribution. Consequently, the researcher utilized paired sample t-tests for the analysis.

Collaborative writing mediation with peers using a learning web portal was transcribed and analyzed primarily on aspects of content, organization, and language use. The microgenetic method was employed to analyze dialogue during student interactions, which included feedback, editing, and corrections during collaboration in completing writing assignments.

In this analysis, each part of the dialogue was examined in relation to the content, organization of writing, and language use in each interaction within the learning web portal media. Additionally, analysis was conducted on student follow-up in completing writing assignments, whether they were completed or not. Each discussion addressing one aspect of writing and reaching a resolution was counted as one part of language dialogue. After reducing the transcription data, the data was coded. The frequency of dialogue mediation between students was calculated. To ensure credibility, writing mediation and its frequency were checked, and data discrepancies were resolved through discussion. The frequency of mediation investigated included components of content, organization, and language use. Chi-square analysis was performed to investigate differences in frequency between student feedback on each aspect.

3.6. Ethical Considerations

Participants were involved in this study voluntarily and without coercion. All participants were asked to fill out a consent form to participate in this study voluntarily. This study has received permission from the Kencana Vocational School, Bandung, Indonesia, as an affiliate of the participants involved. In addition, this study was approved by the Institutional Review Board of Universitas Muhammadiyah Prof. Dr. Hamka, Indonesia, under protocol number Ref. No. 215/B.04.02/2025, dated February 7, 2025. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.

4. RESULTS

4.1. Quantitative Analysis Results

Table 1 presents the findings from the descriptive statistical analysis for the pretest and posttest stages related to writing skills, self-regulation, and writing self-efficacy are presented. The results of the analysis showed that the mean scores did not exhibit significant changes in the pretest phase; nonetheless, a notable difference emerged in both the experimental and control groups during the posttest phase. To gain a more thorough evaluation, additional analysis was performed. A paired sample t-test was conducted to evaluate the effect of incorporating the learning portal website in collaborative writing on the skills needed for writing scientific papers, self-regulation, and writing self-efficacy.

Table 2 displays the results from the paired sample t-test. The t-test analysis revealed significant disparities in writing abilities, self-regulation, and writing self-efficacy between the experimental and control groups. The rise in scores for all competencies in the experimental group was notably greater, with an average score of writing skills [$t = -16.75$, $p < 0.01$], writing self-regulation [$t = -14.84$, $p < 0.01$], and writing self-efficacy [$t = -4.86$, $p < 0.01$]. These findings suggest that the experimental group experienced a greater improvement in the posttest compared to the control group.

The control group exhibited variations in the competency scores from the pretest to the posttest, albeit not significantly.

Table 1. Results of descriptive statistical analysis of writing ability, self-regulation, and writing self-efficacy at the pretest and posttest stages.

	Group	N	Mean	Std. deviation	Std. error mean
Pre-writing performance	Experiment	250	12.43	3.45	0.42
	Control	250	12.52	3.21	0.40
Post-writing performance	Experiment	250	23.38	3.28	0.37
	Control	250	14.32	3.05	0.37
Pre-self-regulation	Experiment	250	15.62	4.06	0.52
	Control	250	15.52	4.46	0.61
Post-self-regulation	Experiment	250	23.58	3.98	0.52
	Control	250	17.88	4.78	0.71
Pre-self-efficacy	Experiment	250	20.50	6.12	0.88
	Control	250	20.45	5.07	0.72
Post-self-efficacy	Experiment	250	27.48	4.42	0.58
	Control	250	21.68	5.51	0.80

Table 2. Results of paired sample t-tests on writing tasks, self-regulation scales, and self-efficacy scales.

Group	Scale	Mean	Std. deviation	Std. error mean	t	df	Sig.
Web	Pre- and post-writing	−5.76	1.09	0.20	−16.75	248	0.01
	Pre- and post-self-regulation	−7.34	2.31	0.52	−14.84	248	0.01
	Pre- and post-self-efficacy	−5.25	6.78	0.94	−4.86	248	0.01
Non-web	Pre- and post-writing	−3.81	1.56	0.36	−9.05	248	0.01
	Pre- and post-self-regulation	−2.96	.98	0.18	−13.41	248	0.01
	Pre- and post-self-efficacy	.86	4.31	0.51	2.32	248	0.03

The following analysis was conducted using a one-way ANCOVA test to investigate differences in writing skills, self-regulation, and writing self-efficacy between the experimental and control groups. Pretest data served as covariates in the ANCOVA analysis. Prior to conducting the one-way ANCOVA, assessments of normalization, linearity, homogeneity, and reliability of the covariates were performed. The results indicated that there were no data breaches, allowing the analysis to proceed. A one-way ANCOVA was then used to examine differences in competence between the two groups. Table 3 presents the results of the one-way ANCOVA analysis indicated significant differences between the collaborative writing groups utilizing the learning portal web platform and those employing traditional or in-person approaches. The analysis showed that the collaborative writing method using the web resources of the learning portal yielded a value of [F (1, 70) = 17.92, p = 0.01, partial eta squared = 0.23]. These findings suggest that using the learning portal site for cooperative writing can significantly improve overall writing skills.

Table 3. Results of the ANCOVA analysis of the writing skills of the two groups.

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Group	22.12	1	22.12	17.92	0.01	0.23

Additional analysis was performed to explore the effect of the intervention on self-regulation skills in writing. The examination of students' self-regulation in writing was assessed through a one-way ANCOVA test shown in Table 4. The analysis results indicated a notable difference in the improvement of writing self-regulation in both groups, with a value of [F (1, 64) = 57.62, p = 0.01, partial eta squared = 0.48]. This result demonstrates that the self-regulation capability enhanced through a collaborative writing intervention using a learning portal website exhibited a greater improvement than those who engaged in traditional collaborative writing. Additionally, a one-way ANCOVA test was performed to examine the writing self-efficacy competence in both groups, as shown in Table 5. The analysis results indicated that the self-efficacy of writing students utilizing the learning portal web exhibited a greater increase than those engaged in conventional collaborative writing, with a value of [F (1, 64) = 18.93, p =

0.01, partial eta squared = 0.22]. This result shows that a writing intervention using a web-based learning portal is more effective at enhancing writing self-efficacy compared to traditional collaborative writing approaches.

Table 4. Results of the ANCOVA test of self-regulation of writing in both groups.

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Group	175.67	1	175.67	57.62	0.01	0.48

Table 5. Results of the ANCOVA test of writing self-efficacy for both groups.

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Group 2	186.56	1	186.56	19.21	0.01	0.25

4.2. Qualitative Analysis Results

The results of the qualitative analysis are presented to support the research findings obtained from the quantitative analysis. These qualitative results were derived from microgenetic analysis and semi-structured interviews. They clarify how the integration of collaborative writing methods with learning web portals enhances writing skills, self-regulation, and self-efficacy in scientific paper writing. Microgenetic analysis was employed to examine peer-to-peer writing mediation, focusing on each dialogue during collaborative writing to investigate inputs, editing, feedback, and improvements within the learning web portal. The analysis concentrated on three aspects: content, organization, and language. In the content aspect, peer-to-peer writing mediations on the learning web portal were categorized into four types of feedback, totaling 118 dialogue messages. These included 76 instances of collaborative writing activities, 23 instances of topic development, 14 instances of message adjustment, and 15 instances of information synthesis. Regarding organizational aspects, peer mediation appeared 18 times within the web media. In the language aspect, 19 types of peer mediation were identified, with a total of 290 dialogue messages. These included 80 verbs, 40 singular and plural words, 33 prepositions, 17 articles, and various other language features. Further detailed analysis of peer-to-peer mediations in each aspect reveals the specific features and patterns observed during the collaborative writing process. Several excerpts from student interviews highlight the features of the learning portal related to content, organization, and language, providing insights into its effectiveness and areas for improvement.

"The discussion room feature provides an opportunity to get feedback from group members discussing the content, making it easier for me to improve aspects of the content" (S4).

"Through the learning portal, each group member can access the scientific papers they have created, making it easier for me and my friends to improve the organization of ideas, add content, and correct grammatical errors" (S9).

"I can underline unclear sentences and replace sentences or paragraphs that lack clear information in the content" (S20).

Student dialogues about content issues in peer-to-peer writing mediations tend to be quite numerous in collaborative writing assignments using learning web portals. The highest frequency of peer-to-peer writing mediations in learning web portals related to content is the clarity of information. This finding shows that improving information in collaborative writing activities is equivalent to enhancing information in scientific papers to make them easier for readers to understand. To improve clarity, some students underline sentences or paragraphs that are unclear and then add replacement sentences. Additionally, in terms of content, some students develop topics and correct sentences by commenting on sentences or phrases that do not match the topic with relevant information. A quote highlighting web portal features that can improve the quality of scientific papers is:

"Several features such as discussion boards, corrections, and feedback can help me correct errors and deficiencies in my scientific papers, so that corrections are made precisely and effectively" (S14).

"The discussion board feature makes it easier for me to coordinate with my group mates while writing, and the feedback feature makes it easier for me to mark, correct, or replace incorrect sections directly." (S19).

Some students consider that the development of topics in each paragraph has interrelated goals and messages so that they produce coherent text. The aspect of idea organization is the least frequent aspect in peer writing mediation dialogue. The systematics of ideas in a written work refers to the introduction, main content, and conclusion and the correlation between ideas in each paragraph. To organize these ideas, some students use transitional vocabulary such as first, next, and finally. In the introduction, for example, students provide input to each other in compiling the rationalization of the background of the problem and the purpose of writing a scientific paper. In the main content, students provide input to each other in ordering the sub-chapters that must be written systematically.

5. DISCUSSION

Drawing from Vygotsky (1978) social constructivist theory, this research aims to explore how the integration of learning portal websites in collaborative writing affects scientific writing abilities, self-regulation, and self-efficacy in writing. The findings from the initial study indicated that the use of a learning portal web integration in collaborative writing notably enhanced students' scientific writing abilities compared to traditional collaborative writing approaches. The improvement in writing skills was evident from the enhancement in the quality of students' writing at the final stage in terms of content, organization, and language use. The learning portal web media was able to mediate students in collaborating to improve their writing across all three aspects. This finding aligns with previous studies, which showed that collaborative writing mediated by web media significantly improved essay writing skills (Ebadi & Rahimi, 2018; Kiziltaş & Kultas, 2025). Based on the theory of social constructivist learning, students are facilitated to collaborate using the learning portal web media so that they are able to mediate students' ZPD, which is ultimately able to reach the optimal potential level in writing scientific papers. The improvement in writing skills was caused by the existence of web media to mediate peer feedback, so that students can improve the quality of their writing (Abedi et al., 2025; Guyer, Stewart, Khalifa, Pham, & Saad, 2024). In addition, feedback and reinforcement from teachers on every aspect of content, organization, and language made students increasingly understand their mistakes so that they were able to fix them.

Students are facilitated through optimal assistance to the minimum level depending on the situation and conditions, whether students can solve problems in their writing process. This process mediates students to move in the zone of proximal development (ZPD) to the stage of achieving independent writing skills. In the final stage, students are able to demonstrate autonomous correction skills in improving their writing. This finding is in line with the theory of microgenetic writing learning, which facilitates students to develop using other people's regulations to develop their own regulations. This finding is also in line with previous studies, which revealed that the features of the learning portal web space facilitate students in effective collaborative writing so that students can correct and provide feedback on writing assignments (Evenstein Sigalov, Cohen, & Nachmias, 2025; Usher, Roll, Fuhrman, & Amir, 2025). This finding is reinforced by the results of previous studies, which revealed that the learning portal web media makes it easy for students to analyze, mediate, and improve all parts of the writing in detail, so that it can enhance the quality of students' writing (Ebrahimi & Ebadi, 2024; Esfandiari & Allaf-Akbary, 2024). The next finding is that collaborative writing interventions facilitated by the learning portal web are able to improve students' writing self-regulation more significantly than conventional collaborative writing methods. This finding is reinforced by previous studies that reveal that the integration of technology in learning methods, which can be regulated by students themselves, will be more optimal in improving students' self-regulation skills because they are given the opportunity to regulate their own learning but still with clear goals or targets (Sovrano, Ashley, Brusilovsky, & Vitali, 2025; Wambsganss, Benke, Maedche, Koedinger, & Käser, 2025).

Another finding from the analysis of interactive dialogues on the web is that in the posttest phase, students become more capable of developing and evaluating aspects of language, including grammar, vocabulary, and writing mechanics. The learning portal web media helps students to plan, organize, and manage tasks more actively so that they are able to improve self-regulation strategies more broadly. This discovery is supported by earlier research

indicating that online writing education assists students in transitioning from peer regulation to self-regulation in enhancing their microgenetic writing skills (Ard et al., 2022; Thi & Nikolov, 2023). The findings from the interviews further support the self-regulation results. The majority of students stated that they could improve their ability to correct and evaluate their own writing and use self-regulation strategies. Independent and collaborative activities facilitated by the learning portal web help students complete writing assignments (Cai & Enríquez Raído, 2025; Huang & Pei, 2024). Students' writing skills initially emerge in groups, also called other settings. Over time, students develop self-regulating writing skills. This self-regulating ability is evident in improvements in content, organization, and language use. This finding is reinforced by the theory that online web media can facilitate students in controlling and managing cognition, affect, and student behavior in collaborative writing (Iyamuremye et al., 2025; Selcuk et al., 2019).

The next finding is that the intervention of using a learning web portal in collaborative writing can improve students' writing self-efficacy. The writing self-efficacy of students in the experimental group increased more significantly than that of students in the control group. This finding is reinforced by previous studies showing that online applications in the writing learning process can improve writing self-efficacy (Ellahi et al., 2024; Jensen, 2018). The environment contributes significantly to students' self-confidence because they have control and get feedback from other students in the writing process, so that writing self-efficacy increases. Increased self-efficacy in completing tasks is seen in their ability to organize content, organization, and linguistic features in writing tasks (Wang et al., 2018; Wang, 2019). The learning environment provided by the learning web portal offers several features that facilitate collaborative writing activities for students, including feedback discussion features, writing improvement tools, processing features for writing sections, and storage options. All of these features contribute to enhancing writing self-efficacy. Results from interviews also indicated that students experienced decreased writing anxiety, reduced dependence on competent peers, and increased motivation to improve their writing due to the portal's features that support these aspects. This finding aligns with the microgenetic theory of writing development, which suggests that the use of appropriate writing media can reduce students' reliance on mediation and foster greater confidence in their abilities (Ellahi et al., 2024; Wang, 2019).

6. CONCLUSION

The integration of a learning portal web into the collaborative writing approach has demonstrated greater effectiveness in enhancing students' scientific writing abilities, self-regulation, and writing self-efficacy compared to traditional collaborative writing methods. The learning portal web media facilitates student interaction, discussion, feedback, and collaborative writing enhancement. Improvements in students' scientific writing skills are evident in the quality of their writing, including content, organization, and language use. Additionally, the development of writing self-regulation is reflected in students' ability to plan, organize, and manage their writing activities independently. An increase in self-efficacy is also observed, as students gain confidence in improving their writing. Furthermore, students' dependence on more competent peers decreases, enabling them to complete their own parts of assignments more independently. This study suggests that using online media in collaborative writing learning can facilitate improvements in writing quality by providing a space for discussion and feedback. It is also important to integrate appropriate learning media with suitable methods to achieve language learning objectives effectively. The study has several limitations, including focusing on only one type of scientific paper, not considering student gender, the short duration of the intervention, and analyzing only content, organization, and language use. The psychological factors analyzed were limited to regulation and writing self-efficacy. Based on these limitations, the researcher recommends testing the intervention on other types of writing, including gender variables in the analysis, extending the intervention period, expanding the focus to include task achievement, cohesion, and coherence, and adding analysis of psychological factors such as motivation and resilience.

Funding: This research was supported by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (124/C3/DT.05.00/PL/2025)
Institutional Review Board Statement: The Ethical Committee of the Universitas Muhammadiyah Prof. Dr. Hamka, Indonesia, has granted approval for this study on 7 February 2025 (Ref. No. 215/B.04.02/2025).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Abedi, A., Shamsabadi, A., Shoraka, H. R., Hosseini, M., Khorashadizadeh, F., Rostami, R., & Namazinia, M. (2025). Design and assessment of a web-based educational electronic system for non-practical nursing skills development among nursing students. *BMC Medical Education, 25*(1), 453. https://doi.org/10.1186/s12909-025-07024-x

Alberth. (2019). Use of Facebook, students' intrinsic motivation to study writing, writing self-efficacy and writing performance. *Technology, Pedagogy and Education, 28*(1), 21–36. https://doi.org/10.1080/1475939X.2018.1552892

Allan, D. (2004). *Assessing language proficiency: A placement test guide*. Cambridge, UK: Language Testing Publications.

Ard, T., Bienkowski, M. S., Liew, S. L., Sepehrband, F., Yan, L., & Toga, A. W. (2022). Integrating data directly into publications with augmented reality and web-based technologies – Schol-AR. *Scientific Data, 9*(1), 298. https://doi.org/10.1038/s41597-022-01426-y

Beis, C. A., Harris, K. N., & Shreffler, S. L. (2019). Accessing web archives: Integrating an archive-it collection into EBSCO discovery service. *Journal of Web Librarianship, 13*(3), 246–259. https://doi.org/10.1080/19322909.2019.1625844

Bustamante, C. (2019). TPACK-based professional development on web 2.0 for Spanish teachers: A case study. *Computer Assisted Language Learning, 33*(4), 327–352. https://doi.org/10.1080/09588221.2018.1564333

Cabero-Almenara, J., & Meza-Cano, J. M. (2019). Online undergraduate students' perceptions of the impact of Web 2.0 on higher education. *Culture and Education, 31*(3), 481–508. https://doi.org/10.1080/11356405.2019.1630953

Cai, Y., & Enríquez Raído, V. (2025). Development of web-based resource usage patterns among English-to-Chinese trainee translators. *Humanities and Social Sciences Communications, 12*(1), 301. https://doi.org/10.1057/s41599-025-04642-0

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Ebadi, S., & Rahimi, M. (2018). An exploration into the impact of WebQuest-based classroom on EFL learners' critical thinking and academic writing skills: A mixed-methods study. *Computer Assisted Language Learning, 31*(5–6), 617–651. https://doi.org/10.1080/09588221.2018.1449757

Ebrahimi, B., & Ebadi, S. (2024). Exploring the impact of screencast-based ipsative assessment on EFL students' writing development. *Language Testing in Asia, 14*(1), 41. https://doi.org/10.1186/s40468-024-00315-y

Ellahi, A., Ain, Q. U., Rehman, H. M., Hossain, M. B., Illés, C. B., & Tanweer, A. (2024). The impact of omnichannel integration towards customer interest in alternatives: Retailer uncertainty and web rooming in retailing. *Cogent Business and Management, 11*(1), 2316931. https://doi.org/10.1080/23311975.2024.2316931

Erguvan, I. D. (2024). What difference does one course make? Assessing the impact of content-based instruction on students' sustainability literacy. *Humanities and Social Sciences Communications, 11*(1), 708. https://doi.org/10.1057/s41599-024-03149-4

Esfandiari, R., & Allaf-Akbary, O. (2024). Assessing interactional metadiscourse in EFL writing through intelligent data-driven learning: The Microsoft Copilot in the spotlight. *Language Testing in Asia, 14*(1), 51. https://doi.org/10.1186/s40468-024-00326-9

Evenstein Sigalov, S., Cohen, A., & Nachmias, R. (2025). Transforming higher education: A decade of integrating Wikipedia and Wikidata for literacy enhancement and social impact. *Journal of Computers in Education, 12*, 953–995. https://doi.org/10.1007/s40692-024-00334-x

Evenstein Sigalov, S., & Konieczny, P. (2025). Writing for the greater good: What do educators think about using Wikipedia as a teaching tool? *Educational Technology Research and Development, 73*, 2739–2760. https://doi.org/10.1007/s11423-025-10505-x

Fathi, J., & Rahimi, M. (2020). Examining the impact of flipped classroom on writing complexity, accuracy, and fluency: A case of EFL students. *Computer Assisted Language Learning, 35*(7), 1668–1706. https://doi.org/10.1080/09588221.2020.1825097

Gánem-Gutiérrez, G. A., & Gilmore, A. (2021). A mixed methods case study on the use and impact of web-based lexicographic tools on L2 writing. *Computer Assisted Language Learning, 36*(7), 1365–1391. https://doi.org/10.1080/09588221.2021.1987273

Guyer, C., Stewart, B., Khalifa, Z., Pham, L., & Saad, A. H. (2024). Implementation and evaluation of an interprofessional prescription writing workshop with a simulated electronic prescribing activity for preclerkship medical students. *BMC Medical Education, 24*(1), 394. https://doi.org/10.1186/s12909-024-05326-0

Han, J., & Hiver, P. (2018). Development and validation of a self-regulation scale for language learning. *Language Learning, 68*(3), 663–694.

Hartfiel, V. F., & Hughey, J. B. (1981). Assessing scientific writing: Development of an evaluation rubric. *Journal of Technical Writing and Communication, 11*(3), 191–205.

Huang, L., & Pei, X. (2024). Exploring the impact of web-based inquiry on elementary school students' science identity development in a STEM learning unit. *Humanities and Social Sciences Communications, 11*(1), 885. https://doi.org/10.1057/s41599-024-03299-5

Iyamuremye, A., Twagilimana, I., & Niyonzima, F. N. (2025). Investigating the impact of using web-based discussion tools on students' conceptual understanding and 21st century skills development in organic chemistry education. *Discover Education, 4*(1), 187. https://doi.org/10.1007/s44217-025-00548-w

Jensen, P. (2018). Semantically enhanced 3D: A web-based platform for spatial integration of excavation documentation at Alken Enge, Denmark. *Journal of Field Archaeology, 43*(sup1), S31–S44. https://doi.org/10.1080/00934690.2018.1510299

Kiziltaş, Y., & Kultas, E. (2025). The effect of Web 2.0 tools on primary school students' writing motivation and their role in developing creative writing skills. *Education and Information Technologies, 30*, 15993–16022. https://doi.org/10.1007/s10639-025-13419-6

Link, S., Mehrzad, M., & Rahimi, M. (2020). Impact of automated writing evaluation on teacher feedback, student revision, and writing improvement. *Computer Assisted Language Learning, 35*(4), 605–634. https://doi.org/10.1080/09588221.2020.1743323

Nasim, S. M., Mohamed, S. M. S., Anwar, M. N., Ishtiaq, M., & Mujeeba, S. (2024). Assessing the pedagogical effectiveness of the web-based cooperative integrated reading composition (CIRC) technique to enhance EFL reading comprehension skills. *Cogent Education, 11*(1), 2401667. https://doi.org/10.1080/2331186X.2024.2401667

Peungcharoenkun, T., & Waluyo, B. (2023). Implementing process-genre approach, feedback, and technology in L2 writing in higher education. *Asian-Pacific Journal of Second and Foreign Language Education, 8*(1), 34. https://doi.org/10.1186/s40862-023-00211-7

Rentier, E. S. (2025). To use or not to use: Exploring the ethical implications of using generative AI in academic writing. *AI and Ethics, 5*, 3421–3425. https://doi.org/10.1007/s43681-024-00649-6

Savarese, M., Usta, D., Bozzoli, F., Fanning, V., Molinari, F., Graffigna, G., & Zaratin, P. (2025). Enhancing patients' role in scientific writing: Insights from a global participatory approach with people with multiple sclerosis. *Research Involvement and Engagement, 11*(1), 14. https://doi.org/10.1186/s40900-025-00687-2

Selcuk, H., Jones, J., & Vonkova, H. (2019). The emergence and influence of group leaders in web-based collaborative writing: Self-reported accounts of EFL learners. *Computer Assisted Language Learning, 34*(8), 1040–1060. https://doi.org/10.1080/09588221.2019.1650781

Sovrano, F., Ashley, K., Brusilovsky, P. L., & Vitali, F. (2025). How to improve the explanatory power of an intelligent textbook: A case study in legal writing. *International Journal of Artificial Intelligence in Education, 35*, 987–1021. https://doi.org/10.1007/s40593-024-00399-w

Thi, N. K., & Nikolov, M. (2023). Effects of teacher, automated, and combined feedback on syntactic complexity in EFL students' writing. *Asian-Pacific Journal of Second and Foreign Language Education, 8*(1), 6. https://doi.org/10.1186/s40862-022-00182-1

Usher, M., Roll, I., Fuhrman, O., & Amir, O. (2025). Supporting coordination and peer editing in students' online collaborative writing processes. *International Journal of Artificial Intelligence in Education, 35*, 1504–1527. https://doi.org/10.1007/s40593-024-00450-w

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds. & Trans.)*. Cambridge, MA: Harvard University Press.

Waer, H. (2021). The effect of integrating automated writing evaluation on EFL writing apprehension and grammatical knowledge. *Innovation in Language Learning and Teaching, 17*(1), 47–71. https://doi.org/10.1080/17501229.2021.1914062

Wambsganss, T., Benke, I., Maedche, A., Koedinger, K., & Käser, T. (2025). Evaluating the impact of learner control and interactivity in conversational tutoring systems for persuasive writing. *International Journal of Artificial Intelligence in Education, 35*, 791–822. https://doi.org/10.1007/s40593-024-00409-x

Wang, C. (2025). Exploring students' Generative AI-assisted writing processes: Perceptions and experiences from native and nonnative English speakers. *Technology, Knowledge and Learning, 30*, 1825–1846. https://doi.org/10.1007/s10758-024-09744-3

Wang, C. Y., Chang, C. K., Lin, K. J., & Chen, G. D. (2018). Effectiveness of web-based mechanism for teaching creative writing in the classroom. *Innovations in Education and Teaching International, 56*(3), 282–294. https://doi.org/10.1080/14703297.2018.1464940

Wang, L. (2019). The impact of computer-mediated contexts on interaction pattern of ESL learners in collaborative writing. *Technology, Pedagogy and Education, 28*(5), 547–562. https://doi.org/10.1080/1475939X.2019.1674183

Wang, L. (2019). Effects of regulation on interaction pattern in web-based collaborative writing activity. *Computer Assisted Language Learning, 35*(1–2), 1–35. https://doi.org/10.1080/09588221.2019.1667831

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind*. Cambridge, MA: Harvard University Press.

Yang, F., & Stefaniak, J. E. (2025). An exploration of instructional designers' prioritizations for integrating ChatGPT in design practice. *Educational Technology Research and Development, 73*, 2761–2784. https://doi.org/10.1007/s11423-025-10509-7

Žáková, K., Urbano, D., Cruz-Correia, R., Guzmán, J. L., & Matišák, J. (2025). Exploring student and teacher perspectives on ChatGPT's impact in higher education. *Education and Information Technologies, 30*, 649–692. https://doi.org/10.1007/s10639-024-13184-y

Zdravkova, K., & Ilijoski, B. (2025). The impact of large language models on computer science student writing. *International Journal of Educational Technology in Higher Education, 22*(1), 32. https://doi.org/10.1186/s41239-025-00525-1