

Improving Students' Critical Thinking, Written Communication, and Collaboration Skills in Ethnoscience-based Problem-Based Learning (PBL) on Ecology Material

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Abstract: Critical thinking, written communication, and collaboration are essential competencies in biology education, yet students often have difficulty applying them to contextual ecological problems. This study examined the effect of ethnoscience-based Problem-Based Learning that integrates the Lampung Topping tradition on these three competencies. A posttest-only quasi-experimental design with intact, nonequivalent groups involved 74 Grade X students selected through cluster random sampling from a population of 297 students. The experimental class ($n = 37$) received ethnoscience-based PBL for three meetings (9×45 minutes), whereas the control class ($n = 37$) received conventional instruction on the same ecology content. Critical thinking and written communication were measured using validated essay tests with Cronbach's alpha coefficients of 0.671 and 0.623, respectively; collaboration was assessed using a structured observation rubric. MANOVA showed a significant multivariate group effect: Pillai's Trace = 0.945, $F(3, 70) = 400.455$, $p < 0.001$. The experimental class outperformed the control class in critical thinking ($M = 88.35$, $SD = 3.90$ vs. $M = 60.22$, $SD = 5.37$; mean difference = 28.14; partial $\eta^2 = 0.902$), written communication ($M = 81.76$, $SD = 11.26$ vs. $M = 56.62$, $SD = 10.93$; mean difference = 25.14; partial $\eta^2 = 0.569$), and collaboration ($M = 89.27$, $SD = 5.72$ vs. $M = 55.03$, $SD = 5.60$; mean difference = 34.24; partial $\eta^2 = 0.904$). The culturally contextualized problems enabled students to connect ecological concepts with local knowledge, construct evidence-based written explanations, and negotiate solutions collaboratively. These findings support integrating local wisdom into biology curricula and teacher professional development while recognizing the study's short duration and single-school context.

Keywords: Collaboration; Critical Thinking; Ethnoscience-Based PBL; Written Communication.

Introduction

The education system continually presents new challenges in response to rapid advances in technology and science. Students are expected to be able to compete globally over time. The current global era demands that education support the development of productive, creative, and innovative human resources capable of solving life's problems. The challenges of 21st-century education require students to possess essential 21st-century skills. Winaryati et al. explain that several key skills fall under personal competencies and have been extensively studied by the US-based Partnership for 21st-Century Skills. These skills are known as "The 4Cs", namely creativity, collaboration, communication, and critical thinking. To support the mastery of these 21st-century skills, students need to be equipped with various relevant skills, one of which is critical thinking [1].

Critical thinking skills are an important aspect of science and are measured by the Programme for International Student Assessment (PISA) survey. The 2022 PISA survey results showed that Indonesian students achieved an average science score of 363. This achievement placed Indonesia in 78th place out of 87 participating

countries. This score is far below the OECD average of 489. Furthermore, these results show a 9-point decrease compared to the 2018 PISA. This indicates that Indonesian students are still relatively weak in working on questions that require HOTS skills, such as questions related to solving real-life problems. Therefore, it can be stated that students' critical thinking skills in problem-solving are categorized as low.

21st-century education requires students not only to think critically but also to master communication skills. One important form of communication is written communication, which is closely related to reading skills and is one of the aspects assessed in the Programme for International Student Assessment (PISA) survey. Based on the 2022 PISA results, Indonesian students achieved an average reading score of 359, ranking 79th out of 87 participating countries. This achievement is still far below the OECD average of 476 and represents a 12-point decrease from the 2018 PISA results. This condition indicates that Indonesian students' written communication skills still face significant challenges. Yet communication skills are crucial for students because they help them understand information, messages, and learning materials from teachers. Sadiman & Haryono stated that the teaching and learning process is essentially a communication process, namely the delivery of

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messages from teachers to students through certain media [2].

Collaborative skills are a crucial competency in 21st-century learning that need to be continuously developed because they can support the growth of student creativity. The results of the 2022 Programme for International Student Assessment (PISA) survey indicate that students in various countries, including Indonesia, still face obstacles in implementing collaborative skills during the learning process. In line with this, the collaboration skills need to be instilled so that students can interact and contribute positively amidst differences [3]. Collaboration itself can be understood as a joint effort to achieve predetermined goals through the division of tasks, directed cooperation, and the involvement of each member in completing work in an integrated manner [4].

Based on interviews with biology teachers and questionnaires distributed to students, 84% of students were familiar with biology. However, 72% of students still experienced difficulties in understanding biology material due to several factors. These difficulties were caused, among other things, by the assumption that biology material is abstract, as stated by 36% of students. In addition, 16% of students stated that the learning model used was not innovative enough, while another 8% considered the teacher's delivery method less interesting.

During Biology lessons, 80% of students stated that their teachers had provided statements or problems for them to solve. Furthermore, 56% of students assessed that the learning model implemented was aligned with ethnoscience. However, interviews with biology teachers revealed that the application of ethnoscience remained limited to the introduction of local wisdom. Interview results also indicated that students had not yet been taught ecology. Therefore, implementing an ethnoscience-based Problem-Based Learning (PBL) model is necessary for learning. This is in line with the questionnaire results, which showed that 88% of students stated the need for an ethnoscience-based PBL model. The implementation of this model is expected to improve students' critical thinking, written communication, and collaboration skills.

Teachers are expected to design and implement innovative learning methods to improve students' critical thinking, written communication, and collaboration skills. The learning strategies used need to be tailored to the desired learning objectives. In line with opinion, developing these three skills requires an appropriate and targeted learning approach [3]. Therefore, selecting an appropriate learning model can significantly encourage students to develop critical thinking, written communication, and effective collaboration skills.

The PBL model is a learning approach that can be used to develop students' critical thinking, written communication, and collaboration skills. The PBL aims to foster students' perseverance, independence, initiative, and problem-solving abilities [5]. Similarly, the stages or syntax of problem-based learning encourage students to actively engage in the learning process, thereby supporting the achievement of critical thinking, written communication, and collaboration skills [6].

Previous studies have demonstrated that problem-based learning integrated with ethnoscience can facilitate students' construction of scientific knowledge through

contextual environmental problems. Ethnoscience-based PBL provides opportunities for students to relate scientific concepts with local cultural practices, thereby improving scientific literacy and higher-order thinking skills [7]. Furthermore, inquiry-oriented and problem-based learning environments encourage students to analyze problems, exchange ideas, and develop solutions collaboratively, which contributes to strengthening critical thinking and collaboration skills [8].

Students' critical thinking, written communication, and collaboration skills can be enhanced through a learning approach that places students at the center of learning activities and connects material to real-life situations in their surroundings [9]. The ethnoscience can be used as a medium and learning resource because students come to school with prior knowledge, experience, and cultural values acquired from family and community [10]. One form of local wisdom that can be integrated into science learning is the Tuppeting Tradition of the Saibatin tribe of Lampung. This tradition is related to scientific concepts, particularly in the Ecology material in Phase E Biology learning for grade 10. Thus, ecological material is a relevant topic to link to ethnoscience based on the Tuppeting Tradition.

The implementation of the ethnoscience-based Problem-Based Learning (PBL) model is expected to develop critical thinking skills, written communication, and student collaboration, while also preserving local wisdom in Biology learning. The use of the PBL model with an ethnoscience approach can influence students' critical thinking skills in reproductive system material [11]. In addition, the implementation of ethnoscience-based PBL has a significant influence on improving students' communication skills [12]. Based on this description, research on "Improving Students' Critical Thinking, Written Communication, and Collaboration Skills in Ethnoscience-based Problem-Based Learning (PBL) on Ecology Material" is warranted.

Problem-Based Learning positions students as active problem solvers who identify what they need to know, investigate evidence, formulate explanations, and evaluate solutions. When PBL is combined with ethnoscience, scientific concepts are reconstructed through culturally familiar practices and environmental experiences. Recent studies have reported that ethnoscience-integrated PBL can improve critical thinking compared with expository instruction [13][14] while broader evidence shows that local-wisdom-based science learning can strengthen scientific literacy and contextual understanding [15]. Meta-analytic studies also indicate positive effects of ethnoscience-based PBL (project-based learning) on higher-order thinking, although the magnitude varies across contexts, subjects, and instruments [16].

The present study used Tuppeting, a South Lampung mask tradition associated with the historical resistance of Radin Intan II and the use of wooden masks and plant materials for disguise [17], as a contextual bridge to ecology. The tradition provides entry points for discussing biotic and abiotic components, organism-environment relationships, resource use, adaptation, and environmental conservation. Rather than treating local wisdom as an illustrative add-on, the intervention embedded Tuppeting and local environmental issues within the five PBL phases: problem orientation, learning organization, investigation, development and

presentation of solutions, and evaluation of the problem-solving process [18].

Previous studies have generally examined a single outcome, specific science topics such as sound, chemistry, or reproduction, or younger student populations [11][14][19]. Although previous studies have reported positive effects of ethnoscience-based learning on students' scientific literacy and critical thinking, investigations published in Jurnal Pijar MIPA have predominantly focused on specific competencies or learning outcomes. For example, ethnoscience-based learning devices have been developed to improve science literacy through contextual learning activities [7]. However, empirical evidence regarding the simultaneous influence of ethnoscience-based PBL on critical thinking, written communication, and collaboration skills in ecology learning remains limited. Evidence remains limited on whether a single ethnoscience-based PBL intervention can simultaneously influence critical thinking, written communication, and collaboration in senior high school ecology learning. The novelty of this study lies in (1) integrating the Topping tradition into ecology problems, (2) assessing three interrelated 21st-century competencies simultaneously through MANOVA, and (3) examining Grade X biology students in an authentic school setting. Therefore, this study investigated whether ethnoscience-based PBL had multivariate and univariate effects on students' critical thinking, written communication, and collaboration skills.

Research Methods

This study employed a quasi-experimental design with a posttest-only nonequivalent control group. The research examined the effect of ethnoscience-based Problem-Based Learning (PBL) integrated with the Lampung Topping tradition on students' critical thinking, written communication, and collaboration skills. The population consisted of Grade X students in the selected school. Samples were selected using cluster random sampling, taking existing classroom groups into account. The selected classes were assigned as the experimental and control groups. The experimental group received learning treatment through ethnoscience-based PBL, while the control group received conventional learning. The intervention was implemented in three meetings, with each meeting lasting 3×45 minutes. Learning activities followed the PBL syntax, including problem orientation, organizing students for investigation, guiding individual and group investigations, developing and presenting solutions, and evaluating the problem-solving process. Data collection instruments consisted of essay tests for critical thinking and written communication skills, and observation rubrics for collaboration skills. The instruments were validated by experts before use. Reliability testing showed Cronbach's alpha values of 0.671 for critical thinking and 0.623 for written communication. Collaboration skills were assessed through structured observation during learning activities. Data analysis was performed using assumption tests, including normality, linearity, homogeneity of variance-covariance matrices, and multicollinearity tests. Hypothesis testing was conducted using MANOVA, followed by univariate analyses, to assess the treatment effect on each dependent variable. The experimental research aims to

determine the effect of a treatment on another variable under controlled conditions [20]. A non-equivalent control group design is the quasi-experimental design used in this study. Based on the hypothesis to be tested, the study involved two classes as subjects. Both classes received the same learning material, namely the structure and function of the female reproductive organs, but used different learning treatments. The experimental class was taught using a Problem-Based Learning (PBL) model integrated with ethnoscience, while the control class received instruction using conventional methods.

This study was conducted on 11th-grade science students at SMA Muhammadiyah 2 Bandar Lampung. This study was conducted in March 2025. The study population consisted of 130 11th-grade science students. Sampling used a non-probability cluster random sampling technique. Data were collected using questionnaires and observations. Furthermore, the data were analyzed using Multivariate Analysis of Variance (MANOVA).

Results and Discussion

The sample data is declared normally distributed because the boxplot results show no univariate outliers, and the scatterplot results show no multivariate outliers. Furthermore, the Pearson correlation coefficient analysis results show a value of 0.988 with a significance level >0.05 . This value indicates a very strong Pearson correlation coefficient.

Table 1. Linearity Test Results

Deviation from Linearity	Sig.
Critical Thinking Experiment * Critical Thinking Control	0.734
Written Communication Experiment * Written Communication Control	0.451
Collaboration Experiment * Collaboration Control	0.895

Based on Table 1, each pair of dependent variables within each group of independent variables shows a linear relationship. For the critical thinking skills variable, the deviation from linearity between the experimental and control classes was 0.734. Furthermore, the deviation from linearity value for the written communication skills variable between the experimental and control classes was 0.451. Meanwhile, the deviation from linearity for the collaboration skills variable between the experimental and control classes was 0.895.

Table 2. Box's Test Results

Box's M	F	df1	df2	Sig.
0.148	0.147	1	145200.000	0.701

The results of the homogeneity test for the variance-covariance matrix indicate that the homogeneity assumption has been met, as shown in Table 2. This is demonstrated by the Box's Test significance value of 0.701, thus concluding that the data have a homogeneous variance-covariance matrix.

Table 3. Tolerance and VIF Values

Variables	Tolerance	VIF
Critical Thinking	0.164	6.106
Written Communication	0.421	2.374
Collaboration	0.141	7.117

Based on Table 3, the tolerance values for the critical thinking, written communication, and collaboration variables were 0.164, 0.421, and 0.141, respectively. Meanwhile, the Variance Inflation Factor (VIF) value for the critical thinking variable was 6.106, the written communication variable was 2.374, and the collaboration variable was 7.117. It can be concluded that the data do not exhibit multicollinearity, as all tolerance values are greater than 0.10 and the VIF values are less than 10.00.

Table 4. MANOVA Test Results

Skill Variable	Sig. Value	Information
Critical Thinking	0.000	There is an influence
Written Communication	0.000	There is an influence
Collaboration	0.000	There is an influence
Critical Thinking, Written Communication, and Collaboration	0.000	There is an influence

The significance value for critical thinking skills is 0.000, for written communication is 0.000, and for collaboration is 0.000, as shown in Table 4. Simultaneous testing of these three variables also showed a significance value of 0.000. Since all significance values were less than $\alpha = 0.05$, it can be concluded that the implementation of the ethnosience-based PBL model significantly impacted students' critical thinking, written communication, and collaboration skills.

Based on the post-test results, the implementation of ethnosience-based PBL was proven to significantly impact students' critical thinking skills. The analysis using the MANOVA test showed a significant value (2-tailed) of 0.000. In accordance with the testing criteria, if the significance value (2-tailed) is <0.05 , it can be concluded that there is a significant effect on students' critical thinking skills after learning with the ethnosience-based PBL model.

The assumption checks indicated no influential univariate or multivariate outliers and supported linearity, homogeneity of covariance matrices, and the absence of problematic multicollinearity. Table 1 presents the descriptive statistics. Students receiving ethnosience-based PBL obtained higher mean scores on all three outcomes. The mean differences were 28.14 points for critical thinking, 25.14 points for written communication, and 34.24 points for collaboration.

Table 5. Descriptive Statistics For The Three Dependent Variables

Outcome	Experimental M $\pm$ SD	Control M $\pm$ SD
Critical thinking	88.35 $\pm$ 3.90	60.22 $\pm$ 5.37
Written communication	81.76 $\pm$ 11.26	56.62 $\pm$ 10.93
Collaboration	89.27 $\pm$ 5.72	55.03 $\pm$ 5.60

Table 6. Multivariate and univariate effects of instructional group

Test/outcome	F (df)	p	Partial η^2
Pillai's Trace =	400.455 (3, 70)	< 0.001	0.945
Critical thinking	665.357 (1, 72)	< 0.001	0.902
Written communication	94.943 (1, 72)	< 0.001	0.569
Collaboration	676.655 (1, 72)	< 0.001	0.904

The multivariate analysis demonstrated a significant overall group effect: Pillai's Trace = 0.945, $F(3, 70) = 400.455$, $p < 0.001$. Thus, the three competencies differed significantly between the experimental and control groups. Follow-up tests showed statistically significant effects for critical thinking, written communication, and collaboration (Table 6). The partial eta-squared values were 0.902, 0.569, and 0.904, indicating that the instructional group accounted for substantial variation in the measured outcomes within this sample.

The effect on critical thinking can be explained by the interaction between contextual familiarity and the cognitive demands of PBL. Topping offered a concrete cultural object through which students could identify ecological components, interpret organism–environment relationships, and examine the sustainability implications of using natural materials. Students were not only asked to recall facts but also to justify classifications, analyze interactions, evaluate claims, draw conclusions, and reconsider solutions. These processes closely correspond to the critical-thinking indicators used in the assessment.

The result is consistent with recent studies reporting higher critical-thinking performance after ethnosience-integrated PBL than after conventional instruction [13][14]. This finding is also consistent with research reported, which showed that inquiry-based learning approaches can enhance students' critical thinking because students are actively involved in investigating problems, constructing explanations, and evaluating evidence [8]. Similarly, ethnosience-based learning has been reported to support scientific reasoning by connecting students' cultural experiences with scientific concepts [7]. It also aligns with evidence that PBL integration can strengthen critical thinking in biology learning [19] and with earlier work using ethnosience-based PBL on reproduction material [11]. The present study extends those findings by demonstrating a strong ecological effect and by positioning a Lampung cultural tradition as the starting point for scientific analysis rather than merely as supplementary information.

The experimental group's higher written-communication score appears to have resulted from repeated opportunities to transform group investigations into written scientific products. The worksheets required students to restate information, use relevant data, construct explanations, and present ecological relationships through diagrams or mind maps. Because the cultural context was familiar, students had a shared referent from which to move toward formal scientific language. The PBL presentation and evaluation stages further required students to revise their explanations in response to questions and alternative viewpoints.

The effect size for written communication was smaller than that for critical thinking and collaboration, although it remained substantial. This difference may reflect the limited number of written tasks, the short intervention, and the greater linguistic complexity of developing coherent scientific writing. The result nevertheless supports research showing that ethnoscience-integrated learning can promote communication by asking students to express culturally grounded scientific ideas in multiple representations [14]. Future interventions should provide more sustained writing cycles, explicit feedback, and separate measures of organization, evidence use, and scientific language.

Collaboration showed the largest mean difference. Ethnoscience-based PBL created a genuine need for students to divide tasks, compare cultural and scientific interpretations, negotiate the relevance of evidence, and agree on a collective solution. The Topping context also provided a shared local issue that encouraged participation and made the discussion less detached from students' lives. These mechanisms support evidence that inquiry- and project-oriented science learning can develop collaboration [21], and recent findings show that ethnoscience-based inquiry can strengthen both critical thinking and collaboration [22]. This result supports findings that student-centered learning approaches emphasizing investigation and interaction can promote collaborative skills. Through group problem-solving activities, students are encouraged to distribute responsibilities, communicate ideas, and negotiate solutions with peers [8].

However, the very large collaboration effect should be interpreted carefully. Collaboration was measured through visible group behaviors during a short intervention, and the study did not report inter-rater reliability. Scores may therefore partly reflect the close alignment between the PBL activities and the observation rubric. Replication using multiple observers, peer assessment, and individual accountability measures would strengthen confidence in the size of the effect.

The study suggests that local wisdom can function as an epistemic resource in biology instruction. For teachers, the central task is not simply to mention a tradition but to reconstruct it as investigable scientific problems, guide students in distinguishing cultural explanations from scientific evidence, and create products that require reasoning, writing, and collective decision-making. Curriculum developers can include locally adaptable ecology cases and worksheets, while teacher professional-development programs can train teachers to identify valid scientific connections, avoid cultural stereotyping, and assess multiple competencies within one learning sequence.

Several limitations constrain the interpretation of the findings. The study involved one school, two intact classes, and only three meetings; therefore, causal generalization beyond the setting should be cautious. The posttest-only design relied on prior semester scores for baseline comparability and could not examine individual growth or retention. The instruments showed moderate reliability, and evidence of inter-rater reliability did not support collaboration. The Topping context is culturally specific, and the unusually large effects may partly reflect instrument-intervention alignment. Future studies should use multicenter randomized or matched designs, pretest-posttest and delayed measures, longer interventions, more

robust writing instruments, and multiple raters. Comparative studies involving different local traditions and ecological contexts are also needed to determine which elements of ethnoscience-based PBL are transferable.

The implementation of the ethnoscience-based PBL model affects students' critical thinking skills. Through this model, students are guided to connect their understanding of ecological concepts with elements of ethnoscience, allowing them to construct understanding more independently while developing critical thinking skills. In line with this, the ethnoscience-based PBL model can develop students' critical thinking skills [23].

In addition to being demonstrated through statistical analysis, the impact of ethnoscience-based PBL implementation on students' critical thinking skills is also evident in several learning stages: presenting problems to students, developing and presenting work, and analyzing and evaluating the problem-solving process. In the problem-orientation stage, students are trained to understand, examine, and analyze the given problems, thereby supporting the interpretation and analysis indicators.

Furthermore, in the development and presentation of results, and in the analysis and evaluation stages of the problem-solving process, ethnoscience-based PBL can encourage the achievement of all critical thinking skill indicators. Students analyze the problems presented at the beginning of the lesson to develop arguments or explain a concept. Afterwards, these ideas are evaluated using various sources and the opinions of other students. This process then continues with drawing conclusions, accompanied by supporting arguments, and their validity is reviewed to reach accurate conclusions. In line with this, the critical thinking skills can be developed if the learning process begins with problem presentation [24].

Several previous studies have shown that implementing ethnoscience-based PBL can improve students' critical thinking skills. The PBL model can influence students' critical thinking skills [19]. In this study, Topping's ethnoscience was integrated into the PBL model because mastery of basic knowledge alone is insufficient to address the challenges of future global development [25]. Research findings indicate that the ethnoscience-based PBL model positively impacts students' critical thinking skills. This finding aligns with the findings that implementing the PBL model with an ethnoscience approach can improve students' critical thinking skills [11].

Based on the post-test results, the implementation of ethnoscience-based PBL was proven to have a significant impact on students' written communication skills. The MANOVA test results showed a 2-tailed significance value of 0.000. According to the testing criteria, if the 2-tailed significance value is <0.05 , it can be concluded that there is a significant impact on students' written communication skills after receiving the ethnoscience-based PBL model.

In addition to statistical analysis, the effect of ethnoscience-based PBL on written communication skills was evident across several stages of learning. The stages of developing and presenting work, as well as analyzing and evaluating the problem-solving process, play a role in supporting all indicators of written communication skills used. Through these stages, students are trained to rewrite information obtained in a way that is clear, coherent, and easy to understand. Furthermore, students are able to present

information scientifically, supported by appropriate data and relevant, easy-to-understand illustrations.

Previous research has shown that implementing ethnoscience-based PBL can improve students' written communication skills. This is in line with the research that ethnoscience-based PBL can influence written communication skills [12]. Based on the findings of this study and supported by previous research, it can be concluded that the implementation of ethnoscience-based PBL influences students' written communication skills in the ecology subject at SMA Muhammadiyah 2 Bandar Lampung.

Based on the observations, the implementation of ethnoscience-based PBL had a significant effect on students' collaboration skills. The results of the MANOVA test showed a sig. (2-tailed) value of 0.000. Referring to the testing criteria, if the sig. (2-tailed) value is <0.05 , it can be concluded that there is a significant effect on students' collaboration skills when learning with the ethnoscience-based PBL model.

In addition to being demonstrated through statistical analysis, the impact of ethnoscience-based PBL on collaboration skills is also evident in several learning stages. These stages include organizing students for learning, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process. Through these stages, students are trained to work together effectively, respect differences within the group, accept others' opinions, and assume responsibility and contribute to achieving shared goals.

Previous research has shown that students' collaboration skills can be improved through the implementation of ethnoscience-based PBL. The use of an ethnoscience-based PBL model significantly impacted students' collaboration skills [26]. Similarly, in ethnoscience-based PBL learning, students' collaborative skills can develop through group discussions, exploration of problems related to local culture, and collaborative solution development [14]. Based on this study's findings, which are supported by prior research, the implementation of ethnoscience-based PBL influences students' collaboration skills in ecology at SMA Muhammadiyah 2 Bandar Lampung.

Conclusion

Based on the analysis conducted, it can be concluded that the ethnoscience-based PBL model has an effect on students' critical thinking skills, written communication, and collaboration in ecology material at SMA Muhammadiyah 2 Bandar Lampung. Based on the findings of this study, several suggestions are provided for further research. Students are expected to understand the importance of the relationship between conventional knowledge and biological concepts through the application of the ethnoscience-based learning model. In addition, research on different learning materials is recommended to strengthen empirical evidence regarding the effectiveness of the ethnoscience-based PBL model. This model has been shown to positively impact students' critical thinking skills, written communication, and collaboration on ecology material at SMA Muhammadiyah 2 Bandar Lampung.

Author's Contribution

M.N. Almarham: plays a role in research planning, intervention, field data collection, data analysis, providing the foundation, and preparing and writing the article manuscript. M. Alfari: plays a role in supervising the entire research process, reviewing and approving the final manuscript for publication, and providing theoretical input. R. Fajarwati: plays a role in supervising the entire research process, reviewing and approving the final manuscript for publication, and providing theoretical input.

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