Susanto, E., Stanggo, P. D., Agustinsa, R., & Mayzora, S. (2026). The Effect of Digital Literacy and Reading Literacy on the Statistical Literacy of Higher Education Students. *Journal of Research in Science and Mathematics Education, 5*(2), 112-122.

Original scientific paper https://doi.org/10.56855/jrsme.v5i2.2129

Received: 24 May 2025.
Revised: 26 June 2026.
Accepted: 08 July 2026.

The Effect of Digital Literacy and Reading Literacy on the Statistical Literacy of Higher Education Students

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Abstract

Purpose: Statistical literacy has emerged as a fundamental competency in higher education, enabling students to critically interpret, evaluate, and communicate data in an increasingly data-driven society. This study investigated the contributions of digital literacy and reading literacy to university students' statistical literacy. **Methodology:** A quantitative correlational design was employed with 147 students from three academic departments within the Faculty of Teacher Training and Education, University of Bengkulu. Data were collected using validated instruments measuring digital literacy, reading literacy, and statistical literacy and analyzed through descriptive statistics and multiple linear regression. **Findings:** Both digital literacy ($\beta = 0.344$, $p < .001$) and reading literacy ($\beta = 0.431$, $p < .001$) exerted significant positive effects on statistical literacy, with the regression model explaining 43.5% of the variance. Reading literacy demonstrated a stronger predictive influence, underscoring the importance of comprehending, evaluating, and synthesizing written information in developing statistical reasoning. Although participants reported relatively high levels of digital and reading literacy, their statistical literacy remained comparatively lower across all departments, suggesting that technological proficiency alone is insufficient to cultivate robust statistical competence. **Significance:** The findings conceptualize statistical literacy as a multidimensional competency requiring the integration of digital, cognitive, and interpretive skills. Strengthening digital literacy alongside reading literacy can substantially enhance students' capacity to interpret and apply statistical information. Accordingly, higher education institutions should embed authentic data-analysis tasks, digital learning resources, and critical reading practices within statistics instruction to better prepare graduates for evidence-based decision-making in increasingly data-intensive contexts.

Keywords: Digital literacy; Higher education; Reading literacy; Statistical literacy; Statistics education; Twenty-first-century skills.

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Introduction

Current global challenges require human resources to have competitiveness and qualified skills. Skills to adapt to the technological era, especially in the 21st century, in the field of education, are very necessary (Reddy et al., 2020). Digital technology has an important role in the progress of various fields (Din et al., 2017), economic development (Reddy et al., 2017), and improving the quality and access to education (Sharma, 2017). Therefore, classroom learning is required to integrate technological innovation and using virtual learning (Puncreobutr, 2016; Susanta et al., 2022). Classroom learning is needed to integrate and encourage technological innovation (Shafie et al., 2019). This aims to produce graduates who master the field of technology.

Technological advances have increased people's exposure to various meanings that require careful statistical interpretation and analysis (Aziz & Rosli, 2021). Statistics is a key component in supporting quality management (Orzes & Dal Bo, 2019), which can be used in education. Statistics play an important role in various human activities because they are used in various fields (Takaria & Talakua, 2018). This shows the importance of mastery of data for everyone to master. The ability to support statistics is important to master in statistical literacy. Statistical literacy is defined as the ability to interpret and evaluate statistical information critically (Koga, 2022). Statistical literacy is a person's ability to formulate, apply, and interpret mathematics in various contexts, including the ability to reason statistically and use concepts, procedures, and facts to describe, explain, or predict an event (Wardhani & Rumiati, 2011).

The concept of statistical literacy remains difficult to understand and sometimes has many meanings, and is a challenge for the education system and teachers (Gal, 2019). This shows that special emphasis is needed on strengthening statistical literacy in learning. Statistical literacy also encompasses an understanding of concepts, vocabulary, and symbols, as well as an understanding of probability as a measure of uncertainty (Ben-Zvi & Garfield, 2004). In the realm of statistics education, teaching to develop students' statistical literacy has contributed to the educational outcomes and abilities of graduates in the real world (Gal, 2002). This shows the importance of statistical literacy skills for students to master, especially in tertiary education.

Efforts to increase students' mastery of statistical literacy in learning can be done by mastering technology. However, in reality, even though students are able to access technology, they are not able to use it efficiently, especially in the learning process (Shopova, 2014). The use of technology can support the achievement of learning objectives (Margaryan et al., 2011). The application of digital media and technology in learning can accelerate the increase in knowledge (Wijaya et al., 2016). Teaching materials that are developed creatively will be able to maximize the achievement of maximum learning outcomes (Susanta & Sumardi, 2022). Classroom learning is needed to integrate and encourage technological innovation and the use of virtual learning (Conklin, 2012; Puncreobutr, 2016; Shafie et al., 2019). In mastering technology, an important skill for students to master is digital literacy. This ability is needed to use digital tools to support goal achievement in their life situations (Fu, 2013). Apart from that, an important ability for students to master in learning is reading literacy. Reading literacy is the ability to understand, interpret, use, and consider the meaning of written texts (Haris et al., 2022). Based on this, it shows that reading literacy skills need to be mastered by students.

The ability to master statistics needs to be emphasized in higher education, especially involving statistical literacy skills. Many studies have been carried out to examine the development of statistical literacy, but the results have not been achieved optimally. Other skills are needed to support them, one of which is digital mastery and reading ability. So, it is necessary to study how students master digital literacy and reading to be able to solve problems related to statistics. Based on the background study and problems described above, the research questions that are the focus of this research are as follows.

1. What is the level of statistical literacy, digital literacy, and reading literacy skills of students in higher education?
2. Does digital literacy affect the statistical literacy of students in higher education?

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3. Does reading literacy influence students' statistical literacy skills in higher education?

Literature Review

Learning Statistics in Higher Education

Statistics learning outcomes in higher education can be improved through the design of teaching materials. Research shows that the use of teaching materials based on realistic cultural contexts can support students' abilities in learning statistics (Susanto & Susanta, 2021). Statistical learning involves knowledge and attitudes (Sharma, 2017). This is because collecting and presenting data requires extensive knowledge about how to collect, analyze, and present data. The development of statistical literacy skills aims to interpret and critically evaluate statistical information or arguments related to data (Büscher, 2024)

Learning to develop statistical literacy requires technology to support success (Schreiter et al., 2024). This condition is formed because technology can present various phenomena in a real way, process data accurately, and provide clear interpretations. In particular, the development of statistical literacy in universities that use technology provides enormous benefits; besides that, the use of statistical literacy in universities covers many social and educational fields.

Statistical Literacy

Statistical literacy is defined as the ability to understand and critically evaluate statistical results encountered in everyday life (Nikiforidou et al., 2010). The ability to communicate information through presentation in the form of diagrams or graphs (Forbes et al., 2011). This ability is connected to scientific reasoning and argumentation, which are used as basic concepts in evidence-based decision making (Fischer et al., 2014). In its use, statistical literacy skills provide roles and benefits in various fields of knowledge, namely science-based studies (Berndt et al., 2021). This requires the importance of statistical literacy to be studied in higher education.

In college students, statistical literacy skills are characterized by the ability to combine basic statistical knowledge and information interpretation skills from statistical analysis (L'Boy & Nazim Khan, 2023). This ability has a role in directing students to have knowledge and understanding of statistics in interpreting numbers from various life problems (Carvalho & Solomon, 2012). Statistical literacy is very important for students and in society (Galesic & Garcia-Retamero, 2011). Through statistical literacy skills, students will be able to analyze and communicate information critically. In this research, the statistical literacy indicators that are the focus of the study are 1) understanding statistical data or information, 2) interpreting statistical data or information, 3) evaluating statistical data or information, 4) communicating statistical data or information.

Digital Literacy

Digital literacy is the ability to access, organize, understand, combine, communicate, evaluate and create information safely and precisely through digital technology devices (Teng, 2018). Perlmutter et al. (2010) stated that the definition of digital literacy is basically formed from three principles, including 1) skills and knowledge to access and use various digital media applications and computer hardware such as mobile phones and internet technology, 2) the ability to critically understand content and applications in digital media, and 3) knowledge and capacity to create something with digital technology. Indicators for measuring student digital literacy are prepared referring to the indicators put forward, which consist of: (1) basic literacy skills, (2) information background, (3) ICT skills, and (4) attitudes and perspectives on using information.

Reading Literacy

Reading literacy is the ability to understand, interpret, use, and consider the meaning of a piece of writing that is read, so that something that is read can make a long-lasting impression on the reader's

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mind (Haris et al., 2022). Reading literacy emphasizes the importance of a student's ability to construct meaning in responding to a text using their knowledge of the text and the context used (Wijaya & Dewayani, 2021). Reading literacy helps a person to see problems from various points of view and consider them as challenges that must be resolved (Lubis, 2020). Reading literacy skills are part of the reasoning skills that are important for students to master to develop 21st-century life skills (Teng, 2019).

According to (Damaianti, 2021), reading literacy is to measure and implement a person's abilities in the learning process and convey written and unwritten information to achieve something. There are three cognitive levels tested in reading literacy, namely (1) access and retrieve, (2) interpret and integrate, and (3) evaluate and reflect. In this research, the focus of this study is on these four indicators, namely: finding information, interpreting information, and evaluating. There are three factors in reading literacy activities, namely: (1) individual cognitive skills, (2) a person's experience and general knowledge about the world, and (3) linguistic knowledge or competence. Indicators of reading literacy ability: 1) understanding reading, obtaining information from reading content, 2) gaining a lot of new knowledge, 3) reflecting or telling about reading content, and 4) being able to make conclusions from reading content (Hardianti & Supriatna, 2019).

Methods

This research uses a correlational research design with a quantitative approach. The research aims to analyze the relationship between digital skills and reading literacy on students' statistical literacy. The research was conducted in three departments–at the Faculty of Teacher Training and Education, University of Bengkulu, namely the Language Department, Mathematics and Natural Sciences Department, and the Educational Science Department. The unit of research analysis is students in study programs in each department. The research involved 12 study programs from three different departments. Sampling used a two-stage random cluster method with proportional probability. In the first stage, 12 study programs were selected proportionally from three departments, Languages (Bahasa), Mathematics and Natural Sciences (MIPA), and educational sciences (JIP), so that a total of 6 study programs were selected. In the second stage, the selection was carried out using a random technique according to the student cohort in each study program in the last three years (2023, 2024, and 2025), where 147 students were selected, as shown in Table 1.

Table 1
Characteristics of Research Respondents

Demographic Characteristics of Respondents		Respondents (*n* = 147)	
		Total	Percentage (%)
Gender	Male	10	6.80
	Female	137	93.20
Enrolment	2023	53	36.05
	2024	63	42.86
	2025	31	21.09
Department	Languages	65	44.22
	Mathematics and Natural Sciences	56	38.09
	Educational sciences	26	17.69

Data Collection Technique

Data collection in this research used tests. Data collection instruments consist of instruments measuring digital literacy, reading literacy, and statistical literacy. Each instrument is developed in multiple-choice form. The instrument is arranged based on indicators with the number of items digital literacy (*n* = 20 items), reading literacy (*n* = 20 items), and statistical literacy (*n* = 15 items). Each instrument has gone through a validity test using correlation techniques. In addition, the instrument was tested for reliability based on internal consistency using the Cronbach's alpha correlation technique.

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Based on testing on 30 non-sample students, the Pearson correlation value for each instrument item met the valid criteria. Meanwhile, the results of the reliability test showed that the internal consistency of each instrument, as measured by Pearson correlation, met valid criteria with a Cronbach's α coefficient > 0.70 (Bonett & Wright, 2015).

Data Analysis

The research data were analyzed using descriptive statistics consisting of mean, median, mode, standard deviation. The score for each variable is converted on a scale of 0-100 with the following criteria: (0-20: very low); (21-40): low, (41-60: medium); (61-80: high); and (80-100: Very high). To test the hypothesis, the influence of LD and LM variables on statistical literacy was tested using parametric analysis with SPSS-assisted linear regression testing and a confidence level of 95%. The focus of test analysis is carried out on testing: (1) F test results, (2) analysis of t test results, (3) analysis of the coefficient of determination (R2) test results based on linear regression test output. As a prerequisite, the data have gone through normality analysis, heteroscedasticity, and data multicollinearity tests. Test the hypothesis using multiple linear regression with the following equation.

$\hat{Y} = a + b_1X_1 + b_2X_2$

$\hat{Y}$ = Statistical Literacy

a = constant, b_{1-2} = Regression coefficient, X_1= Digital literacy, X_2= Reading literacy

Results and Discussions

Description of Student Digital Literacy Capabilities

Digital literacy measures students' basic abilities in digital mastery, especially as a support for lectures. Students' digital literacy abilities based on scores in completing test questions are described by department group in Table 2.

Table 2

Description of digital literacy skills

Department	Mean	Max	Min	Std.Dev
Educational sciences	80.51	100.00	30.00	15.54
Mathematics and Natural Sciences	83.69	100.00	46.67	10.86
Languages	75.38	93.33	40.00	13.95

The descriptive statistics presented in Table 2 reveal notable differences in students' digital literacy across the three academic departments. Students from the Department of Mathematics and Natural Sciences achieved the highest mean score (M = 83.69, SD = 10.86), indicating a high level of digital literacy with relatively low variability in performance. This finding suggests that digital literacy competencies were consistently well developed among students in this department. Students from the Department of Educational Sciences obtained a mean score of 80.51 (SD = 15.54), with scores ranging from 30 to 100, reflecting a generally high level of digital literacy accompanied by greater variability in individual performance. In comparison, the Language Department recorded the lowest mean score (M = 75.38, SD = 13.95), indicating comparatively weaker digital literacy competencies than the other two departments and moderate variability in achievement. Overall, these findings demonstrate that students in the Department of Mathematics and Natural Sciences exhibited the highest and most consistent levels of digital literacy, followed by those in the Department of Educational Sciences, whereas students from the Language Department displayed comparatively lower digital literacy, highlighting the need for targeted instructional strategies to strengthen their effective use of digital technologies in academic learning.

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Description of students' reading literacy abilities

Data on students' reading literacy abilities, especially in understanding text and figures. The results of the analysis of reading literacy skills based on majors at FKIP UNIB are summarized in Table 3.

Table 3

Description of reading literacy skills

Department	Mean	Max	Min	Std.Dev
Educational sciences	66.46	100	10	18.99
Mathematics and Natural Sciences	74.11	100	40	14.62
Languages	61.54	90	10	23.78

Based on Table 3, students' reading literacy levels varied across the three academic departments. Students from the Department of Mathematics and Natural Sciences achieved the highest mean score (M = 74.11, SD = 14.62), indicating relatively strong reading literacy with limited variability in performance. This finding suggests that most students in this department demonstrated consistently high levels of reading comprehension and interpretation skills. In contrast, students from the Department of Educational Sciences obtained a mean score of 66.46 (SD = 18.99), reflecting a moderate level of reading literacy accompanied by greater variability in achievement. The Language Department recorded the lowest mean score (M = 61.54), with scores ranging from 10 to 90 and the largest standard deviation (SD = 23.78), indicating comparatively weaker reading literacy and substantial disparities in students' performance. Overall, these findings demonstrate that students from the Department of Mathematics and Natural Sciences exhibited the highest and most consistent reading literacy, followed by those from the Department of Educational Sciences, whereas students from the Language Department displayed the lowest levels of reading literacy and the greatest variation in achievement across the three academic departments.

Description of students' statistical literacy abilities

Data on statistical literacy skills, namely, students' basic abilities in understanding statistics, are summarized in Table 4.

Table 4

Description of statistical literacy skills

Department	Mean	Max	Min	Std.Dev
Educational sciences	68.08	100.00	8.33	20.65
Mathematics and Natural Sciences	69.20	100.00	8.33	19.26
Languages	52.56	91.67	8.33	25.25

Table 4 indicates that there are differences in the level of reading abilities between departments. The Department of Mathematics and Natural Sciences has the highest average, namely 69.20, with a maximum score of 100, a minimum of 8.33, and a standard deviation of 19.26. The Department of Educational Sciences has an average of 68.08 with a maximum score of 100, a minimum of 8.33, and a standard deviation of 20.65, which means that the reading ability of Educational Sciences students is also quite good. However, there is slightly greater variation in ability compared to Mathematics and Natural Sciences students. Meanwhile, the Language department had the lowest average, namely 52.56, with a maximum score of 91.67, a minimum of 8.33, and the highest standard deviation of 25.25. This shows that the reading ability of language major students is relatively low and very varied, with quite significant differences in ability between individuals. Overall, these results illustrate that Mathematics and Natural Sciences students have the best and most stable reading abilities, followed by Education Sciences

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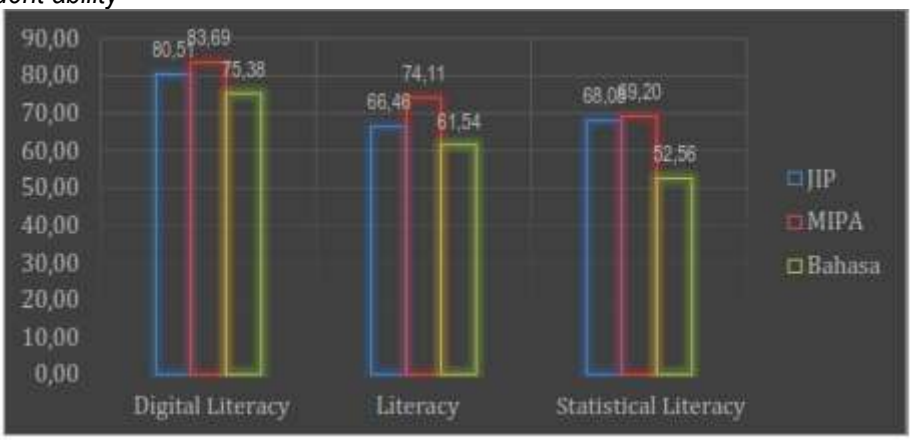
students, while students majoring in Languages show the lowest reading abilities with a high level of variation. Comparison of digital literacy, language literacy, and statistical literacy skills based on majors, as shown in the following picture.

Figure 1
Average student ability



As illustrated in Figure 1, which shows the comparison of digital literacy, reading literacy, and statistical literacy skills between departments, it can be seen that there are differences in literacy levels in each department. In general, the MIPA department showed the highest average scores in the three aspects of literacy, namely 83.69 for digital literacy, 74.11 for reading literacy, and 69.20 for statistical literacy. This shows that MIPA students have the highest overall literacy skills. The JIP department is in second place with an average score of 80.51 in digital literacy, 66.46 in reading literacy, and 68.08 in statistical literacy. Meanwhile, the Language department has the lowest average score in these three aspects, namely 75.38 in digital literacy, 61.54 in reading literacy, and 52.56 in statistical literacy.

From these results, it can be interpreted that Mathematics and Natural Sciences students are higher in various aspects of literacy, especially digital literacy and statistics, which may be influenced by the characteristics of the field of study, which requires analytical skills and intensive use of digital technology. Education Science students show quite good abilities, but they still vary, while students majoring in Languages have the lowest literacy skills among the three. Overall, this graph illustrates that students' literacy levels are influenced by their respective scientific fields, where majors with a science and technology orientation tend to have higher literacy skills.

Hypothesis Testing Results

Hypothesis testing in this research has passed the prerequisite analysis. The data for each research variable meet normality criteria based on the Kolmogorov-Smirnov test, with a significance level for each variable of more than α=0.05. The data also show that none of the independent variables has a significant effect on the dependent variable (not heteroscedastic). Meanwhile, the multicollinearity test shows that the tolerance values are greater than 0.1 and the VIF values are less than 10 for each independent variable. So that multicollinearity does not occur. Based on this test, the data can be used to test hypotheses (regression test), with the results shown in Table 5.

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Table 5
Regression model test results

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	-19.687	9.517		-2.069	.040
	Digital literacy	.637	.129	.344	4.925	.000
	Reading literacy	.496	.080	.431	6.181	.000

a. Dependent Variable: Statistical literacy

The digital literacy regression coefficient value is 0.637 with a significance value of 0.000 (<0.05), indicating that digital literacy has a positive and significant effect on statistical literacy. This means that every one unit increase in digital literacy will increase statistical literacy by 0.637 units, assuming other variables are constant. The standard beta coefficient (0.344) also shows that digital literacy has quite strong influence on statistical literacy skills.

Meanwhile, the reading literacy regression coefficient of .496 with a significance value of .000 (< .05) also shows a positive and significant influence on statistical literacy. This means that every one unit increase in reading literacy will increase statistical literacy by 0.496 units. The standard Beta value (0.431) indicates that reading literacy has a slightly greater influence on students' statistical literacy than digital literacy. To analyze the influence of the independent variable on the dependent variable, the following results are presented.

Table 6
Model summary of effect test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.659[a]	.435	.427	16.47676

a. Predictors: (Constant), reading literacy, digital literacy

Based on the analysis results, an R-squared value of 0.435 was obtained. This means that the variable effect is 0.435, indicating that the independent variable accounts for 43.50% of the variance in the dependent variable, while the others are influenced by variables not the focus of the research. The presented research results demonstrate both partial and simultaneous influences between digital literacy and reading literacy on students' statistical literacy. The combined influence of these two variables exceeds 40%. Both abilities positively impact statistical literacy. This means that the higher a person's digital literacy and reading skills, the better their statistical literacy skills. Students who master digital literacy will find it easier to understand statistics. This aligns with the opinion of Demmanggasa et al (2023), who emphasised that digital literacy is not merely the ability to operate technological devices but also encompasses understanding, analysing, and utilising digital information effectively and ethically.

The research results show that students' digital literacy skills impact the development of mathematical literacy. This aligns with Naufal (2021) view that students with digital literacy are better at understanding information. Furthermore, digital literacy skills aid students in critical thinking and communication (Sujana & Rachmatin, 2019), and in information processing (Restianty, 2018). Furthermore, statistical literacy requires the ability to read and interpret statistical information (Maryati & Priatna, 2018), thus enhancing reading skills. Supporting research shows that reading habits can improve critical thinking skills (Doang et al., 2022), this is crucial for mastering statistics.

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Conclusions

This study demonstrates that both digital literacy and reading literacy are significant predictors of university students' statistical literacy. Although students generally exhibited relatively strong digital literacy, their statistical literacy remained comparatively lower, indicating that access to and familiarity with digital technologies alone are insufficient for developing the ability to interpret, evaluate, and communicate statistical information. The regression analysis further revealed that reading literacy contributed slightly more strongly than digital literacy to statistical literacy, highlighting the fundamental role of reading comprehension and critical interpretation in statistical reasoning. These findings reinforce the view that statistical literacy is a multidimensional competence requiring the integration of technological, cognitive, and interpretive skills rather than procedural statistical knowledge alone.

From a theoretical perspective, this study extends previous research by empirically demonstrating the complementary contributions of digital literacy and reading literacy to statistical literacy within a higher education context. Rather than functioning independently, these competencies appear to interact in supporting students' ability to engage critically with statistical information in digitally mediated learning environments. This finding contributes to the growing body of literature advocating an integrated literacy framework for developing essential twenty-first-century competencies.

Practically, the findings suggest that higher education institutions should embed digital literacy and academic reading strategies into statistics instruction instead of treating them as separate learning outcomes. Statistics courses should therefore incorporate authentic data-analysis tasks, digital learning resources, critical reading of statistical reports, and evidence-based interpretation activities that simultaneously strengthen students' technological proficiency and analytical reasoning.

This study is limited by its cross-sectional correlational design and the use of participants from a single university, which restrict the generalizability of the findings and precludes causal inference. Future research should employ longitudinal or experimental designs involving more diverse institutional contexts to investigate causal relationships and explore additional factors, such as critical thinking, data literacy, mathematical reasoning, self-efficacy, and artificial intelligence literacy, that may further explain variations in students' statistical literacy.

Acknowledgements

The author would like to thank the Institute for Research and Community Service (LPPM) Bengkulu University and the Publication and Publishing Unit (UPP) FKIP UNIB for their financial support, which enabled the study to be carried out.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research.

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