



The Role of Elementary School Teachers in Integrating Climate Change Education to Support Students' Literacy and Numeracy in Achieving the Sustainable Development Goals

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Abstract: This study investigates the role of elementary school teachers in integrating Climate Change Education (CCE) and its contribution to teachers' perceived support for literacy and numeracy in elementary learning. A quantitative survey was conducted with 100 elementary school teachers using a Likert-scale questionnaire measuring teacher role, CCE integration, literacy support, and numeracy support. The instrument demonstrated adequate validity ($r\text{-count} = 0.48\text{--}0.67 > r\text{-table} = 0.195$) and reliability (Cronbach's $\alpha = 0.79\text{--}0.86$). Descriptive findings indicated relatively high mean scores for teacher role (3.72), CCE integration (3.65), literacy support (3.58), and numeracy support (3.49). Correlation analysis showed positive relationships between teacher role and CCE integration ($r = 0.68$), literacy support ($r = 0.62$), and numeracy support ($r = 0.55$). Regression analysis further revealed that teacher role significantly predicted CCE integration ($R^2 = 0.46$; $\text{Sig.} = 0.000$). Teacher role also made significant contributions to perceived literacy support ($R^2 = 0.384$; $p < 0.001$) and perceived numeracy support ($R^2 = 0.303$; $p < 0.001$), indicating a stronger contribution to literacy than numeracy. These findings underscore the strategic role of teachers in embedding CCE into competency-oriented elementary instruction and in fostering literacy and numeracy through environmentally relevant learning contexts.

Keywords: Climate Change Education; Elementary schools; Literacy; Numeracy; Role of teachers

Introduction

Climate change is one of the global challenges that has a significant impact on various aspects of human life, including the environment, economy, and society (Herman et al., 2017; Plutzer et al., 2016). The impacts of climate change, such as rising global temperatures, changes in rainfall patterns, floods, and environmental degradation, are increasingly being felt in many parts of the world, including Indonesia. Therefore, education plays an important role in increasing public awareness

and understanding of climate change issues from an early age. One approach that can be implemented is the integration of Climate Change Education (CCE) into the school learning process (Brundiers et al., 2010; Rousell & Cutter-Mackenzie-Knowles, 2020).

Elementary school is a strategic stage of education for shaping students' knowledge, attitudes, and skills related to the environment (Ibourk et al., 2025; Monroe et al., 2019). At this level, teachers play an important role in integrating environmental issues, including climate change, into classroom learning activities. The

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integration of climate change education not only aims to increase students' environmental awareness, but can also provide a meaningful learning context for developing basic competencies such as literacy and numeracy. Literacy and numeracy are fundamental competencies in basic education because both play an essential role in strengthening critical thinking, problem-solving ability, and the capacity to understand information in everyday life.

In the context of learning, climate change materials can be used as contextual learning resources. For example, students can read texts on the impacts of climate change on the local environment to improve literacy skills, while also analyzing simple data such as temperature, rainfall, or seasonal changes to develop numeracy skills. Thus, the integration of CCE in learning can support the achievement of literacy and numeracy competencies in a more meaningful way (Nasrudin et al., 2022; Yasukawa, 2023). This linkage is particularly relevant in the Indonesian education context, where literacy and numeracy remain national priorities in strengthening foundational learning. Positioning climate change issues as part of literacy- and numeracy-oriented instruction can therefore make learning more contextual, interdisciplinary, and responsive to contemporary educational needs.

North Kayong Regency in West Kalimantan Province is an area characterized by coastal environments and tropical forests that are vulnerable to various impacts of climate change, such as floods, coastal abrasion, and changes in seasonal patterns. This condition makes climate change education an important aspect that needs to be introduced to students from the elementary school level (Aisyah et al., 2023; Kusnadi & Sukmawati, 2023; Sukmawati & Wahjusaputri, 2024). In such a vulnerable setting, literacy and numeracy are not only basic academic skills but also practical competencies needed to understand environmental information, interpret warning messages, read seasonal patterns, and engage with simple quantitative data related to climate risks. This means that the urgency of CCE in North Kayong lies not only in raising environmental awareness, but also in supporting students' ability to respond to local environmental challenges through foundational competencies. However, the implementation of climate change education integration in elementary school learning still faces various challenges, such as limited teacher understanding of climate change concepts, a lack of relevant learning resources, and suboptimal integration of environmental content into literacy and numeracy learning. Preliminary observations in North Kayong schools further indicate that climate-related issues are still often treated as separate topics and have not yet

been systematically linked to core literacy and numeracy lessons.

Teachers, as learning facilitators, have a strategic role in designing and implementing instruction that integrates climate change issues with the development of students' literacy and numeracy competencies. Therefore, it is important to examine how elementary school teachers play their role in integrating climate change education into classroom learning and how such integration is perceived by teachers to support students' basic competencies, rather than directly measuring improvements in students' actual performance (Sukmawati et al., 2025). Unlike previous studies that focus primarily on environmental awareness, this study specifically examines the intersection of CCE with the national priority of literacy and numeracy in a disaster-prone coastal context. This constitutes the novelty of the study, as it positions CCE not merely as environmental content, but as a pedagogical context for supporting foundational competencies in elementary education.

Based on this background, this study aims to analyze the role of elementary school teachers in integrating Climate Change Education (CCE) to support student literacy and numeracy in North Kayong Regency, West Kalimantan, Indonesia. More specifically, this study seeks to explain how teachers perceive the integration of CCE as a means of supporting literacy and numeracy within elementary classroom practice. The results of this research are expected to contribute to the development of more contextual learning strategies and support the improvement of the quality of basic education oriented to environmental issues and the strengthening of students' basic competencies (Ibourk et al., 2025; Nasrudin et al., 2022).

Method

This study uses a quantitative approach with a survey design to analyze the role of primary school teachers in integrating climate change education (CCE) to support students' literacy and numeracy (Alam & Singla, 2024; Oppewal, 2010). This approach was chosen to obtain an empirical picture of the relationship between the integration of climate change education in learning and teachers' support for students' literacy and numeracy skills. The research was carried out in several elementary schools in North Kayong Regency, West Kalimantan Province, Indonesia, with data collection conducted in the 2025 academic year. The research flow can be seen in Figure 1.

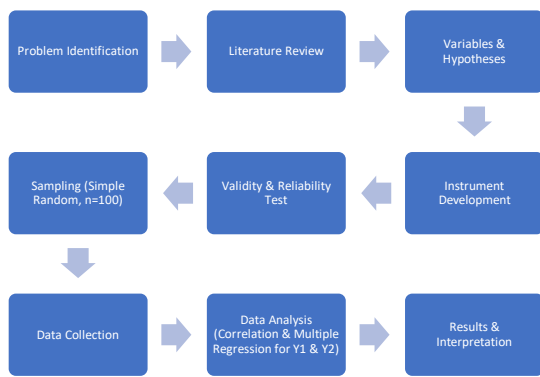


Figure 1. The research flow

The population in this study consists of elementary school teachers in North Kayong Regency. The sampling technique uses simple random sampling, assuming that all teachers have relatively equal involvement in the learning process. If specific criteria are applied, such as teaching experience or certification, these criteria are explicitly defined to ensure clarity and consistency (Aslam, 2021; Richter & Werner, 2015; Sireci & Soto, 2016). The total sample in this study is 100 elementary school teacher respondents from several schools in North Kayong Regency.

The research instrument uses a questionnaire with a Likert scale of 1–5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The instrument measures four main variables: (1) Teacher Role (X_1), (2) CCE Integration (X_2), (3) Literacy Support (Y_1), and (4) Numeracy Support (Y_2). Each variable is operationally defined with distinct indicators to avoid overlap. In particular, CCE Integration focuses on the extent to which teachers incorporate climate change issues into learning, while Literacy Support and Numeracy Support focus on how teachers facilitate literacy and numeracy activities, respectively, including the use of environmental data for reading comprehension and mathematical operations.

The data analysis technique in this study uses quantitative statistical analysis with the help of statistical software. The analysis begins with a validity test using Pearson Product Moment correlation to determine the validity of each questionnaire item, followed by a reliability test using Cronbach's Alpha to measure the internal consistency of the instrument. Next, a normality test is conducted on the regression residuals using Shapiro–Wilk. For a sample size of 100, this test remains acceptable, although alternative tests such as Kolmogorov–Smirnov may also be considered (Ahad et al., 2011; Koning, 2008; Thakur et al., 2023).

Furthermore, Pearson correlation analysis is used to examine the relationships between variables. To test the effect of independent variables on dependent variables, this study employs two multiple linear regression models, given that literacy and numeracy are conceptually distinct constructs. The regression models are formulated as follows:

$$Y_1 = a + b_1X_1 + b_2X_2 + e \tag{1}$$

$$Y_2 = a + b_1X_1 + b_2X_2 + e \tag{2}$$

Where Y_1 represents teachers' support for literacy, Y_2 represents teachers' support for numeracy, a is a constant, b_1 and b_2 are regression coefficients, X_1 is the role of teachers in climate change education, X_2 is the integration of Climate Change Education (CCE), and e is the error term.

The results of the regression analysis are used to determine the influence and contribution of teacher roles and CCE integration on the intensity of teachers' support for literacy and numeracy activities, rather than directly measuring students' competencies (Dukes, 2006; Ebner & Henze, 2023; Liu et al., 2025). The research instrument is presented in Table 1.

Table 1. Questionnaire Instruments

Variable	Indicator	Statement
Teacher Role in CCE	Teachers' ability to explain the concept of climate change	I was able to explain the basic concepts of climate change to students.
	Teachers' ability to explain the concept of climate change	I can explain the impact of climate change on the environment around students.
	Integration of climate change issues in learning	I integrate climate change material into classroom learning activities.
	Integration of climate change issues in learning	I relate the topic of climate change to the subject matter I teach.
	Use of environment-based contextual learning methods	I use the example of the surrounding environment in explaining the climate change material.
	Use of environment-based contextual learning methods	I use environmental problem-based learning methods in learning.
	Use of climate change materials in learning	I use learning materials or resources related to climate change in learning.

Variable	Indicator	Statement
Climate Change Education Integration (CCE Integration)	Use of climate change materials in learning	I include the topic of climate change in discussion activities or student assignments.
	Utilization of examples of local environments in learning	I use the example of local environmental events to explain climate change.
	Utilization of examples of local environments in learning	I associate climate change with environmental conditions in the North Kayong area.
	Use of environmental data in learning	I use environmental data such as temperature or rainfall in learning.
Literacy Support	Use of environmental data in learning	I ask students to analyze simple environmental data in learning.
	Use of environment-related text or reading	I use texts or readings about the environment in learning.
	Use of environment-related text or reading	I ask students to read articles or stories about climate change.
	Discussion and understanding of environmental information	I encourage students to discuss the issue of climate change.
	Discussion and understanding of environmental information	I help students understand environmental information from a variety of reading sources.
	Development of reading and writing skills related to environmental issues	I give the assignment of writing about environmental issues or climate change.
	Development of reading and writing skills related to environmental issues	I use reading activities to improve students' understanding of climate change.
Student Numeracy Support	Use of environmental data in mathematics learning	I use environmental data in math learning.
	Use of environmental data in mathematics learning	I associate mathematical calculations with environmental phenomena.
	Analysis of figures or graphs related to climate change	I ask students to read graphs or tables related to climate change.
	Analysis of figures or graphs related to climate change	I use graphs or diagrams to describe the environment data.
	Environmental data-driven troubleshooting	I gave a math problem related to environmental data.
Environmental data-driven troubleshooting	I ask students to solve problems based on available environmental data.	

Result and Discussion

Results

Based on the results of the analysis of research data, the average scores of the four variables studied were obtained, namely the role of teachers in Climate Change Education (CCE), the integration of CCE in learning, support for student literacy, and support for student numeracy (Christmann & Aelst, 2005; Pastore, 2017; Trizano-Hermosilla & Alvarado, 2016). The average scores are presented in graphical form to facilitate comparison between variables. Data Visualization (Figure 1): To improve clarity and ensure the figure is not merely textual, the results are presented using a bar chart that visually compares the mean scores of each variable. Figures must be clear, non-scanned, and presented in high resolution. This graph shows an overview of the implementation of climate change education in school learning as shown in Figure 2.

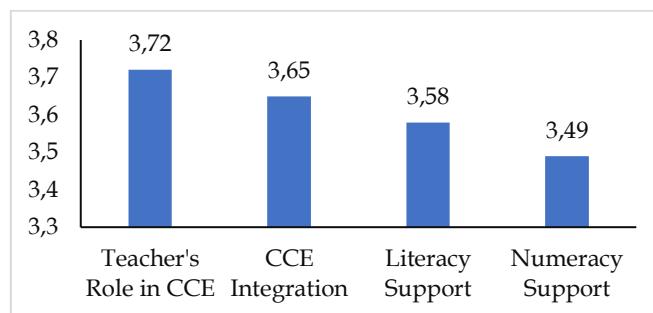


Figure 2. Average questionnaire results for each variable

Figure 2 shows that the role of teachers in Climate Change Education (CCE) has an average score of 3.72, which is included in the high category (3.41–4.20). The CCE integration variable has an average value of 3.65 and literacy support of 3.58, which are also in the high category. Meanwhile, numeracy support has an average value of 3.49, which falls into the moderately high category. This indicates that, in general, the implementation of climate change education in learning

is good, although numeracy support still needs to be improved (Izally et al., 2026) (Yay, 2022).

The relatively lower score in numeracy support (3.49) compared to literacy (3.58), although marginal, may indicate practical challenges faced by teachers. These may include limited teaching aids for presenting climate-related data (e.g., graphs, statistics) and varying levels of teachers' confidence in applying mathematical concepts in environmental contexts. Previous studies suggest that integrating real-world data into numeracy instruction requires both pedagogical and content knowledge (Pastore, 2017; Trizano-Hermosilla & Alvarado, 2016).

Validity Test

Based on the data obtained from the questionnaire given to the respondents, instrument validation data was obtained as in table 2.

Table 2. Instrument Validation Test Results

Variable	Item	r	r	Remarks
		Count	Table	
The Role of the Teacher	PG1	0.62	0.195	Valid
	PG2	0.64	0.195	Valid
	PG3	0.58	0.195	Valid
	PG4	0.60	0.195	Valid
	PG5	0.67	0.195	Valid
	PG6	0.55	0.195	Valid
CCE Integration	IC1	0.59	0.195	Valid
	IC2	0.57	0.195	Valid
	IC3	0.63	0.195	Valid
	IC4	0.65	0.195	Valid
	IC5	0.52	0.195	Valid
	IC6	0.50	0.195	Valid
Literacy	L1	0.60	0.195	Valid
	L2	0.56	0.195	Valid
	L3	0.62	0.195	Valid
	L4	0.64	0.195	Valid
	L5	0.53	0.195	Valid
	L6	0.58	0.195	Valid
Numeracy	N1	0.49	0.195	Valid
	N2	0.52	0.195	Valid
	N3	0.55	0.195	Valid
	N4	0.60	0.195	Valid
	N5	0.48	0.195	Valid
	N6	0.51	0.195	Valid

Based on the results of the validity test, all items in each variable have a calculated r value greater than the r table (0.195), so that all statement items in the research instrument are declared valid and can be used in the research (Oppewal, 2010; Richter & Werner, 2015; Sireci & Soto, 2016).

Reliability Test

Based on the data obtained, the following is the data from the reliability test as shown in table 3.

Table 3. Results of the Feasibility Test

Variable	Alpha	Categories
The Role of the Teacher	0.86	High reliability
CCE Integration	0.84	High reliability
Literacy	0.82	High reliability
Numeracy	0.79	Fairly high reliability

Based on Table 3, all variables have a Cronbach's Alpha value greater than 0.70, indicating that the instrument is reliable (Christmann & Aelst, 2005; Trizano-Hermosilla & Alvarado, 2016).

Normality Test

Based on the data obtained with 100 and the distribution of the dominant score between 3-4, it can be seen in table 4.

Table 4. Normality Test Results

Variable	Sig	Conclusion
The Role of the Teacher	0.086	Normal
CCE Integration	0.091	Normal
Literacy	0.078	Normal
Numeracy	0.067	Normal

Based on table 4 data, the results of the normality test showed that all variables had a significance value (Sig) greater than 0.05, namely the role of the teacher of 0.086, CCE integration of 0.091, literacy of 0.078, and numeracy of 0.067. This shows that the data on each variable is normally distributed (Koning, 2008; Thakur et al., 2023).

Correlation Test

Based on the data obtained, the following correlation for each variable can be seen in table 5 data.

Table 5. Correlation Test Results

Variable	r	Interpretation
Teacher Roles - CCE Integration	0.68	Strong
The Role of Teachers - Literacy	0.62	Strong
The Role of the Teacher - Numeracy	0.55	Medium
Integration - Literacy	0.64	Strong
Integration - Numeracy	0.58	Medium

Based on the data in Table 5, it can be explained that the role of teachers has a positive relationship with the integration of Climate Change Education (CCE), literacy, and numeracy of students. This means that the better the role of teachers in learning, the better the implementation of CCE and support for students'

literacy and numeracy skills (Liu et al., 2025; Wang et al., 2024). This shows that teachers have an important role in developing students' understanding of climate change issues through learning activities.

Regression Test

To determine the role of teachers in the integration of Climate Change Education (CCE), a regression test was carried out as shown in table 6 data.

Table 6. Regression Results Data

Variable	t count	R2	Sig
The Role of the Teacher	8.21	0.46	0.000

Based on the data in table 6, the Sig value < 0.05, it is concluded that the role of teachers has a significant effect on the integration of Climate Change Education (CCE) in learning (Christmann & Aelst, 2005; Izally et al., 2026). This shows that the better the role of teachers, the better the application of climate change materials in learning activities. In addition, in the regression test, an R value was obtained 0.46 which means that 46% of CCE integration is influenced by the role of teachers, the rest by other factors.

Table 7. Multiple Regression Results for Literacy Support (Y₁)

Variable	B (Unstandardized)	Std. Err	Beta (Standardized)	t-value	Sig.
(Constant)	1.10	0.35	-	3.14	0.002
Teacher Role (X ₁)	0.42	0.08	0.45	5.25	0.000
CCE Integration (X ₂)	0.38	0.09	0.39	4.22	0.000

Table 7 shows that Teacher Role (X₁) and CCE Integration (X₂) have a positive and significant effect on Literacy Support (Y₁) (Sig. = 0.000 < 0.05). Teacher Role (B = 0.42) has a slightly stronger influence than CCE Integration (B = 0.38). The model explains 52% of the variance (R² = 0.52), and the overall regression is significant (F = 52.31; Sig. = 0.000).

Table 8. Multiple Regression Results for Numeracy Support (Y₂)

Variable	B (Unstandardized)	Std. Err	Beta (Standardized)	t-value	Sig.
(Constant)	1.05	0.37	-	2.84	0.006

Teacher Role (X ₁)	0.36	0.09	0.38	4.00	0.000
CCE Integration (X ₂)	0.41	0.10	0.40	4.10	0.000

The results show that Teacher Role (X₁) and CCE Integration (X₂) have a positive and significant effect on Numeracy Support (Y₂) (Sig. = 0.000 < 0.05). CCE Integration (B = 0.41) has a slightly stronger influence than Teacher Role (B = 0.36). The model explains 48% of the variance (R² = 0.48), and the overall regression is significant (F = 45.67; Sig. = 0.000).

Discussion

This study aims to analyze the role of elementary school teachers in integrating *Climate Change Education* (CCE) to support literacy and numeracy of students in North Kayong Regency, West Kalimantan, Indonesia. The results of the study show that teachers have a significant role in integrating climate change issues in learning so that they are able to support the development of students' literacy and numeracy skills (Lammert, 2024b; Makrooni et al., 2026; Rousell & Cutter-Mackenzie-Knowles, 2020). The statistical analysis conducted in this study, which included validity, reliability, normality, correlation, and regression tests, showed that the research instruments had good methodological quality as well as statistically significant intervariable relationships

The results of the validity test showed that all questionnaire items used in this study were declared valid. The r-value calculated on the teacher role variable ranged from 0.55-0.67, while the CCE integration variable ranged from 0.50-0.65. Meanwhile, in the literacy support variable, the r-value of the calculation is in the range of 0.53-0.64, and in the numeracy support variable it ranges from 0.48-0.60. All of these values are greater than the r-value of the table of 0.195, so it can be concluded that each statement item in the questionnaire is able to measure the construct in question precisely. The validity of this instrument shows that the questions asked in the research have been able to describe the role of teachers in explaining the concept of climate change, linking it to learning, and encouraging literacy and numeracy activities through environmental issues (Andrea & Petkou, 2022; Monroe et al., 2019; Plutzer et al., 2016).

In addition to being valid, this research instrument also has a high level of reliability. The results of the reliability test showed that the value of Cronbach's Alpha in the teacher role variable was 0.86, the CCE integration variable was 0.84, the literacy support variable was 0.82, and the numeracy support variable

was 0.79. This value indicates that all variables have a good level of internal consistency because they are above the recommended minimum limit of 0.70. This means that the research instrument is able to provide stable and consistent measurement results in measuring the variables being studied. High reliability is an indicator that the data obtained from respondents can be trusted and is suitable for use in further research analysis (Brundiers et al., 2010; Herman et al., 2017; Ibourk et al., 2025; Nasrudin et al., 2022).

The results of the normality test also showed that the research data met the assumption of normal distribution. The significance value for the variable of the teacher's role was 0.086, CCE integration was 0.091, literacy support was 0.078, and numeracy support was 0.067. All of these values are greater than 0.05, so it can be concluded that the data is normally distributed (Lammert, 2024a; Tapia & Reith, 2025; Yasukawa, 2023). Normal data distribution allows researchers to use parametric statistical analysis such as correlation and regression to determine the relationship and influence between variables in this study.

Based on the descriptive analysis, an overview was obtained that the role of teachers in climate change education was in the high category with an average score of 3.72. This shows that most teachers have been able to explain the basic concepts of climate change to students, relate climate change material to the subject, and use examples of the surrounding environment in the learning process. The Climate Change Education integration variable also has a high average score of 3.65, which indicates that teachers have begun to include climate change topics in learning, student assignments, and class discussions (Boaventura et al., 2021; Gelmez Burakgazi & Reiss, 2024; Satchwell et al., 2025). Meanwhile, the student literacy support variable had an average score of 3.58, which shows that teachers are quite active in using environmental texts, climate change articles, and reading and discussion activities as part of learning.

However, the numeracy support variable has a slightly lower average value of 3.49, although it is still in the fairly high category. This shows that the use of environmental data, climate change graphs, and data-based problem-solving is still not optimal in learning. These findings show that the integration of climate change education in literacy learning has been more developed compared to the integration in numeracy learning (Leve et al., 2023; Martinez Sainz et al., 2026).

The results of the correlation test showed that there was a positive relationship between the role of teachers and the integration of Climate Change Education, literacy, and numeracy of students. The value of the correlation coefficient between the role of the teacher

and the integration of CCE was $r = 0.68$, which indicates a strong relationship. Meanwhile, the relationship between the role of teachers and literacy support was $r = 0.62$, and the relationship between the role of teachers and numeracy support was $r = 0.55$. These values show that the better the role of teachers in integrating climate change materials in learning, the better the integration of CCE and support for students' literacy and numeracy skills.

These findings are in line with constructivist theory, which states that the learning process will be more effective when students build their own knowledge through interaction with real experiences and environments. In the context of climate change education, teachers can help students understand the concept of climate change by relating learning materials to environmental phenomena they experience in their daily lives. Through a contextual learning approach, students not only acquire knowledge theoretically but also understand the relevance of the concept in real life (Sukmawati et al., 2026).

Furthermore, the results of the regression test show that the role of teachers has a significant effect on the integration of Climate Change Education in learning. The significance value obtained was 0.000 (<0.05) with a regression coefficient of 0.68. The regression equation obtained was $Y = 1.12 + 0.68X$, which indicates that every one unit increase in the teacher's role would increase the integration of CCE by 0.68. In addition, a determination coefficient value (R^2) of 0.46 showed that 46% of the variation in CCE integration was influenced by the role of teachers, while the rest were influenced by other factors such as curriculum, school support, and teacher competence in teaching climate change issues.

The results of this study are in line with UNESCO's view that climate change education must be integrated into various subjects so that students gain a comprehensive understanding of global environmental issues. Climate change education aims not only to increase students' knowledge about climate change, but also to develop critical thinking skills, problem-solving skills, and environmental awareness from an early age (Fauziah & Sukmawati, 2023; Nurliana & Sukmawati, 2023).

The relationship between the integration of CCE and student literacy in this study also suggests that climate change learning can be an effective context for developing reading and comprehension skills (Kusnadi & Sukmawati, 2023; Novianti et al., 2023; Sukmawati & Zulherman, 2023). When teachers ask students to read environmental articles, discuss climate change issues, or write reports on environmental conditions, students not only learn about climate change but also develop their literacy skills.

On the other hand, the integration of CCE in numeracy learning still needs to be strengthened. Numeracy in climate change education includes the ability to read temperature change graphs, understand rainfall data, and analyze environmental information quantitatively. The use of environmental data in mathematics learning can help students understand the relationship between mathematical concepts and real-world environmental phenomena (Ibourk et al., 2025; Tapia & Reith, 2025; Yasukawa, 2023).

If associated with the condition of North Kayong Regency, the integration of climate change education is very important because this region has a wealth of natural resources and ecosystems that are vulnerable to environmental change. By integrating climate change issues in learning, students can understand the environmental conditions around them and develop awareness to maintain environmental sustainability (Gelmez Burakgazi & Reiss, 2024; Lammert, 2024a).

The results of this study show that the role of teachers is an important factor in the successful integration of Climate Change Education in elementary schools. Teachers not only play the role of delivering learning materials, but also as facilitators who help students understand climate change issues through contextual and meaningful learning activities. Therefore, improving teachers' competence in integrating climate change education and the development of local environment-based teaching materials is an important step in strengthening the implementation of CCE in elementary schools (Boaventura et al., 2021; Leve et al., 2023; Satchwell et al., 2025). This research makes an important contribution to the development of climate change education in Indonesia, especially in improving the integration of CCE to support the development of literacy and numeracy of elementary school students.

Conclusion

This study concludes that the teacher's role has a significant influence on the integration of Climate Change Education (CCE) in elementary school learning in North Kayong Regency, West Kalimantan. Furthermore, both teacher role and CCE integration contribute to strengthening instructional support for literacy and numeracy, although the effect is relatively stronger for literacy than numeracy. These findings indicate that while CCE has been implemented at a generally high level, numeracy support remains comparatively lower, suggesting challenges in integrating climate-related data into mathematical learning activities. This is particularly relevant in the context of North Kayong as a coastal area, where climate

change issues are highly contextual but require stronger quantitative teaching approaches. Therefore, the North Kayong Education Office is recommended to prioritize targeted teacher training focused on the use of environmental data for numeracy learning, while school principals should support the provision of contextual teaching resources that integrate local climate issues into classroom practice.

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Author Contributions

Conceptualization was carried out by G.A.; methodology was developed by D.N.M.; software was managed by H.B.; validation was conducted by B.; formal analysis was performed by I.Y.; investigation was undertaken by T.H.; resources were provided by G.A.; data curation was handled by G.A.; writing original draft preparation was completed by U.H.; writing review and editing were carried out by H.B.; visualization was prepared by I.Y.; supervision was provided by T.H.; project administration was managed by G.A.; and funding acquisition was secured by G.A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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