A Preliminary Study on Teacher Interaction, Teaching Methods, and the Development of Creativity in Early Childhood Within the Framework of SDG 4

Mutia Afnida[1][a], Gracia Mandira[2][b], Harlina Ramelan[1][c], Yosa Yulia Nasri[3][d], Tisna Syafnita[1][e] and Ade Herdian Putra[4][f]

[1]*Department of Early Childhood Education Universitas Negeri Padang, Indonesia*
[2]*Department of Early Childhood Education Universitas Syiah Kuala, Indonesia*
[3]*Department of Special Education, Universitas Negeri Padang, Indonesia*
[4]*Department of Guidance and Counselling, Universitas Negeri Padang, Padang, Indonesia*
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Abstract: Education in the twenty-first century faces a dual imperative: enhancing teacher–student interaction and fostering children's creativity as a foundation for achieving Sustainable Development Goal 4 (SDG 4). While active teaching practices are widely promoted, many studies suggest they remain largely knowledge-oriented and insufficiently aligned with creativity development or sustainability objectives. The novelty of this research lies in the development of a structural model that positions children's creative abilities not only as an outcome, but also as a mediator linking teaching method, teacher instruction, and SDG achievement. Using a quantitative design, the study applied Structural Equation Modeling–Partial Least Square (SEM-PLS) with elementary school teachers in Padang, Indonesia. Five constructs were measured: teaching method, teacher instruction, stimulation of children's creativity, children's creative abilities, and SDG 4 achievement. revealed that teaching method significantly influences teacher instruction, but has no direct effect on creativity or SDGs. Negative associations emerged between teacher instruction and children's creative abilities and between creativity stimulation and SDGs. Importantly, teaching method indirectly supports SDG 4 through children's creative abilities. These findings underscore creativity as a vital bridge between pedagogy and sustainable development, while highlighting the need for less rigid instruction and stronger integration of sustainability in teaching practices.

1 INTRODUCTION

Education in the twenty-first century faces a dual challenge: strengthening teacher–student interaction while simultaneously fostering children's creativity as a foundation for achieving Sustainable Development Goal 4 (SDG 4). Although active teaching methods have been shown to enhance classroom interaction, their direct impact on creativity and sustainability outcomes remains inconclusive. For example, Bullard & Bahar (2023) highlights structural constraints in teaching practices that tend to suppress creativity when instruction is overly rigid. Similarly, at the global level, UNESCO (2021) emphasizes the urgent need for a holistic transformation of education, including creativity and critical thinking as essential competencies for advancing SDG 4.

Educational theories such as constructivism and critical pedagogy support the idea that teacher

[a] https://orcid.org/0000-0002-0578-2035
[b] https://orcid.org/0000-0003-0361-5361
[c] https://orcid.org/0009-0001-8121-9957
[d] https://orcid.org/0009-0000-5436-1846
[e] https://orcid.org/0009-0008-6033-9360
[f] https://orcid.org/0000-0002-6646-2457

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instruction should not be limited to knowledge transmission but should instead cultivate creativity and reflective thinking. However, there is still a limited body of empirical research that explicitly links teaching methods, teacher instruction, children's creativity, and sustainable development outcomes. In the Indonesian context, the integration of sustainability values into teaching practices is still at an early stage. A systematic literature review by Druker-Ibáñez & Cáceres-Jensen (2022)found that sustainability perspectives are rarely embedded into local educational research, particularly in language learning and pedagogy. This reveals a knowledge gap between the urgent need for creativity-driven education and its practical implementation in classrooms.

The novelty of this study lies in the development of a structural model connecting teaching method, teacher instruction, stimulation of children's creativity, children's creative abilities, and SDG 4 achievement. Unlike previous studies, this research positions children's creative abilities not merely as an outcome but as a mediating mechanism that links pedagogical practices with sustainable education goals. This perspective offers a more systematic understanding of how creativity can serve as a bridge between everyday teaching and global sustainability objectives.

The urgency of this research is underscored by the approaching 2030 deadline for the SDGs, which calls for more concrete contributions from education systems. Strengthening teaching practices that enhance creativity and critical skills is crucial for preparing children to act as agents of sustainable change. This study therefore seeks to provide empirical evidence and practical insights for educators, policymakers, and researchers in designing teaching approaches that are not only effective in instructional terms but also meaningful in supporting global development goals.

The following are the 8 hypotheses proposed in this study:

H1: There is a positive and significant correlation between Teaching Method and Teacher Instruction.

H2: There is a positive and significant correlation between Teaching Method and Stimulation Children Creativity.

H3: There is a positive and significant correlation between Teaching Method and Childrens' Creative Abilities.

H4: There is a positive and significant correlation between Teaching Method and SDGs 4 Achievement.

H5: There is a positive and significant correlation between Teacher Instruction and Stimulation Children Creativity.

H6: There is a positive and significant correlation between Teacher Instruction and Childrens' Creative Abilities.

H7: There is a positive and significant correlation between Teacher Instruction and SDGs 4 Achievement.

H8: There is a positive and significant correlation between Stimulation Children Creativity and Childrens' Creative Abilities.

H9: There is a positive and significant correlation between Stimulation Children Creativity and SDGs 4 Achievement.

H10:Stimulation Children Creativity mediates the correlation between Teaching Method and Childrens' Creative Abilities.

H11:Stimulation Children Creativity mediates the correlation between Teacher Instruction and Childrens' Creative Abilities.

H12: Stimulation Children Creativity mediates the correlation between Teaching Method and SDGs 4 Achievement.

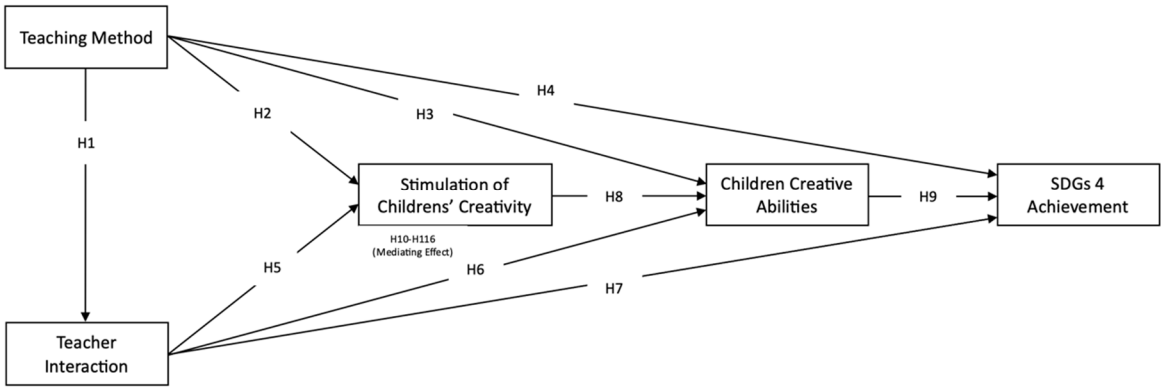

Figure 1: Conceptual Model.

H13: Stimulation Children Creativity mediates the correlation between Teacher Instruction and SDGs 4 Achievement.
H14: Childrens' Creative Abilities mediates the correlation between Teaching Method and SDGs 4 Achievement.
H15:Childrens' Creative Abilities mediates the correlation between Teacher Instruction and SDGs 4 Achievement.
H16:Childrens' Creative Abilities mediates the correlation between Stimulation Children Creativity and SDGs 4 Achievement.

2 METHOD

This study employed a quantitative approach using Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the structural relationships among Teaching Method, Teacher Interaction, Variety of Teaching Methods, Stimulation of Children's Creativity, SDG 4 Achievement, and Children's Creative Abilities. Data were collected through questionnaires administered to teachers and classroom observations of children's behavior to assess their creative abilities.

A quantitative approach was chosen because it is particularly suitable for confirmatory research, which aims to test theoretical models using empirical data and to evaluate hypotheses that have been explicitly formulated (Hair et al., 2019). Accordingly, the research design adopted was PLS-SEM.

PLS-SEM is a multivariate analysis technique widely applied in social science and educational research because it is capable of examining complex causal relationships among latent constructs, even in large models or when the data do not meet the assumption of normal distribution (Hair et al., 2021). In this study, PLS-SEM was used to validate the conceptual model linking Teaching Method, Teacher Interaction, Variety of Teaching Methods, Stimulation of Children's Creativity, SDG 4 Achievement, and Children's Creative Abilities. This design provides a robust analytical framework to empirically test the hypothesized relationships and to confirm the theoretical model supported by previous literature.

2.1 Population and Sample

The population of this study consisted of all kindergartens in Padang City, totaling 335 institutions, comprising 5 public and 330 private kindergartens, based on official data from the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (*https://referensi.data.kemendikdasmen.go.id/pendidikan/paud/086100/2/jf/1/s2*).

The sampling technique employed was stratified sampling to ensure proportional representation from each district in Padang City. From this population, a total of 200 teachers and 200 children. The teachers represented both public and private kindergartens across all districts of Padang, while the children were randomly chosen from selected classes and were within the age range of 5–6 years.

Based on the demographic analysis of respondents, this study involved teachers from various types of schools and administrative regions. The majority of respondents were teachers from private schools (90%), while only a small proportion came from public schools (10%). This indicates that the sample was dominated by private school educators, reflecting the prevalence of private institutions in the study area.

In terms of teaching experience, most respondents had worked for more than ten years (64.5%), suggesting that the sample largely consisted of senior teachers with substantial professional experience. Teachers with shorter experience were less represented, with 14% having 1–3 years, 12% having 7–9 years, 6.5% with 3–5 years, and only 3% with 5–7 years of service. This distribution highlights that the majority of participants were highly experienced, while novice teachers formed a relatively small segment of the sample.

The distribution of school locations also shows considerable diversity. The largest groups of teachers were concentrated in Padang Utara (20.5%), Koto Tangah (19.5%), and Lubuk Begalung (16.5%). Several other districts, such as Padang Timur (12.5%), Padang Barat (5.5%), Padang Selatan (7%), Nanggalo (5%), Bungus Teluk Kabung (3.5%), Lubuk Kilangan (3.5%), and Pauh (2.5%), contributed smaller proportions. Kuraji accounted for 4%. This spread indicates that the research covered a wide geographic area, though the concentration of respondents was higher in certain regions compared to others.

In sum, the demographic profile shows that the sample was largely composed of experienced teachers from private schools, distributed across a wide range of geographical areas in Padang. This composition offers a comprehensive overview of the respondents' background and provides a solid basis for interpreting the subsequent findings within the specific educational context of the study.

Table 1: Demographics of Research Respondents.

Demographic Categories	Sub-Category	Total	Percentage
Teachers	Public School	20	10%
	Private School	180	90%
Teaching experience	1-3 years	28	14%
	3-5 years	13	6.5%
	5-7 years	6	3%
	7-9 years	24	12%
	>10 years	129	64.5%
School Location	Bungus Teluk Kabung	7	3.5%
	Koto Tangah	39	19.5%
	Kuranji	8	4.0%
	Lubuk Begalung	33	16.5%
	Lubuk Kilangan	7	3.5%
	Nanggalo	10	5.0%
	Padang Barat	11	5.5%
	Padang Selatan	4	7%
	Padang Timur	25	12.5%
	Padang Utara	41	20.5%
	Pauh	5	2.5%

Source: Field Data (2025)

2.2 Research Instrument

The instruments used in this study consisted of five measurement scales designed to assess the variables of Teaching Method, Teacher Interaction, Variety of Teaching Methods, Stimulation of Children's Creativity, Creative Abilities, and SDG 4 Achievement. The selection of instruments was based on their relevance to the research constructs and on previous studies that had demonstrated their validity and reliability.

The adaptation process was adjusted to the context of early childhood education in Padang City, following recent international guidelines on the translation and cross-cultural adaptation of measurement instruments, as recommended by Cruchinho et al. (2024). These guidelines emphasize the importance of a structured procedure, including forward–backward translation, expert panel review, and pilot testing, in order to ensure conceptual, linguistic, and cultural equivalence across all constructs measured.

2.2.1 Teacher Questionnaire

In the teacher questionnaire, two latent variables were measured, namely Teaching Method (TM) and Teacher Interaction (TI), using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The items were developed based on a review of the literature and validated by six experts in the field.

2.2.2 Observation of Children's Creative Abilities

In this study, children's creative abilities were assessed through systematic observation of their behaviors during classroom learning activities. The dimensions of creativity evaluated encompassed novelty, flexibility, elaboration, and persistence. Observations were carried out within the natural classroom setting to preserve ecological validity and to minimize potential sources of bias.

To ensure the validity and reliability of the constructs prior to the main analysis, the study assessed convergent validity and internal consistency reliability for all constructs in the model. The results indicated that all constructs met the required criteria.

The average loading factor values for all constructs were above 0.7, demonstrating that the indicators used were valid in measuring their respective constructs. Both Cronbach's Alpha and Composite Reliability (CR) values exceeded the minimum threshold of 0.7, indicating that the research instrument was reliable and consistent in measuring the variables under study. In addition, the Average Variance Extracted (AVE) values for each construct were greater than 0.5, showing that more than 50% of the variance in the indicators was explained by the construct they represented.

Accordingly, all constructs—including Children's Creative Abilities, SDG 4 Achievement, Stimulation of Children's Creativity, Teacher Instruction, and Teaching Method—were confirmed to be valid and reliable, and thus appropriate for use in the

subsequent structural model analysis using PLS-SEM. The detailed results of the construct validity and reliability tests are presented in Table 3.

All questionnaire items were assessed using a five-point Likert scale. For the constructs of Teaching Method, Teacher Interaction, Stimulation of Children's Creativity, Variety of Teaching Methods, and Creative Abilities, participants evaluated the frequency of the observed behaviors on a scale ranging from 1 (never) to 5 (always).

In contrast, the SDGs 4 Achievement construct was measured using a scale from 1 (strongly disagree) to 5 (strongly agree). In this measurement framework, higher scores across these constructs reflect a greater intensity or prevalence of the respective attributes as perceived by the respondents.

2.3 Data Collection Procedure

Data were collected between June and August 2025. The teacher questionnaires were distributed directly to schools using a Google Form, while children's creativity was observed by trained enumerators who monitored classroom learning activities.

2.4 Data Analysis

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the latest version of SmartPLS. This method was chosen because it is well suited for confirmatory research that examines complex causal relationships among latent constructs, can handle non-normal data, and is

Table 2: Research Instruments.

Instruments	Indicators	N of items	Sample
Teaching Method	Learning Approach	18	Teacher
	Teaching Strategies and Techniques		
	Active Involvement of Children		
	Utilization of Learning Resources		
	Providing Freedom and Exploration		
	Consistency and Clarity of Steps		
Teacher Interaction	Reciprocal communication	18	Teacher
	Feedback provision		
	Emotional scaffolding / Affective support		
	Frequency and intensity of positive engagement		
	Equitable role distribution		
	Instructional responsiveness		
Stimulation of Children Creativity	Originality Stimulation	12	Teacher
	Flexibility Stimulation		
	Exploration Stimulation		
	Elaboration Stimulation		
Creative Abilities	Originality	12	Children
	Flexibility		
	Elaboration		
	Persistence		
SDGs 4 Achievement	Availability of facilities and infrastructure	10	School
	Non-discriminatory acceptance		

Source: Field Data (2025)

Table 3: Construct Reliability and Validity Results.

Construct	Average Loading Factor	Decision	Cronbach's Alpha	Decision	Composite Reliability (CR)	Outer T-statistic	Decision
Children Creative Abilities	0.781	Valid	0.790	Reliable	0.862	AVE (0.610)	Valid
SDGs 4 Achievement	0.867	Valid	0.715	Reliable	0.862	AVE (0.759)	Valid
Stimulation of Children's Creativity	0.812	Valid	0.832	Reliable	0.886	AVE (0.661)	Valid
Teacher Interaction	0.825	Valid	0.895	Reliable	0.919	AVE (0.656)	Valid
Teaching Method	0.834	Valid	0.912	Reliable	0.932	AVE (0.696)	Valid

Source: Field Data (2025)

appropriate for large samples (Ali et al., 2018). The analysis involved two main stages: evaluation of the outer model (convergent validity, discriminant validity, and reliability) and the inner model (hypothesis testing, path coefficients, t-statistics, p-values, and R-square), in order to assess theoretical validity, the strength of relationships, and the predictive power of the model.

The evaluation of model fit indicated that the research model showed an adequate level of alignment with the empirical data. The SRMR value was 0.054 for the saturated model and 0.055 for the estimated model, both below the threshold of 0.08, which indicates a good fit. The NFI index also demonstrated satisfactory results, with values of 0.862 for the saturated model and 0.861 for the estimated model, exceeding the minimum standard of 0.80 and confirming that the model achieved an acceptable level of fit. Furthermore, the d_G and d_ULS values were relatively consistent between the saturated and estimated models, suggesting that the model possessed good stability in its estimations.

The comparison of Chi-square values (487.318 for the saturated model and 488.750 for the estimated model) also showed only a very small difference, reinforcing that the model used was consistent with the structure of the data analyzed. Taken together, these results indicate that the structural model developed in this study can be considered appropriate and feasible for use in testing the research hypotheses.

Table 4: Model Fit.

Model Fit Criteria	Saturated Model	Estimated Model
SRMR	0.054	0.055
NFI	0.862	0.861
d_G	0.275	0.276
d_ULS	0.735	0.755
Chi-square	487.318	488.750

Source: Field Data (2025)

3 RESULT

3.1 Outer Model

The evaluation of the outer model aimed to assess the quality of the measurement model by examining the reliability and validity of the indicators for each construct. This evaluation included tests of convergent validity, discriminant validity, and internal consistency reliability.

The results of the PLS-SEM analysis showed that all indicator loadings exceeded the threshold of 0.70, indicating that each item strongly represented its corresponding latent construct. The Average Variance Extracted (AVE) values for all constructs were also above 0.50, confirming adequate convergent validity.

The structural model presented revealed that only a subset of the hypothesized paths between constructs was statistically significant. In particular, the relationships between Teaching Method and Teacher Instruction, Teacher Instruction and Children's

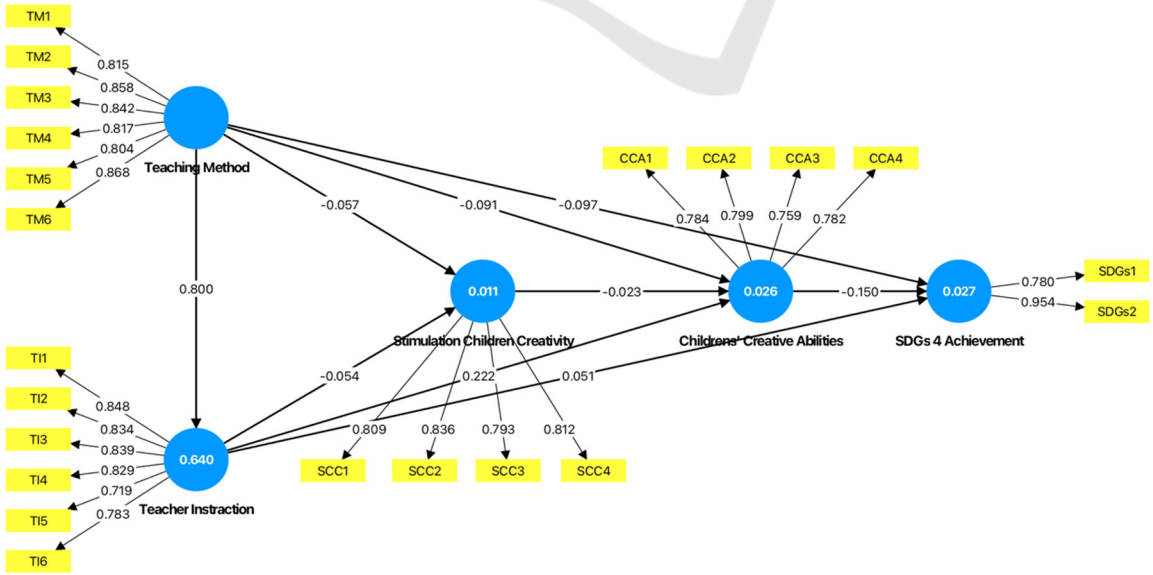

Figure 2: Measurement Model Evaluation.

Table 5: Loading Factor Value.

	Teaching Method (TM)	Teacher Interaction (TI)	Stimulation Childrens' Creativity (SCC)	Children Creative Abilities (CCA)	SDGs 4 Achievement (SDGs)
TM1	0 815				
TM2	0.858				
TM3	0.842				
TM4	0.817				
TM5	0.804				
TM6	0.868				
TI1		0.848			
TI2		0.834			
TI3		0.839			
TI4		0.829			
TI5		0.719			
TI6		0.783			
SCC1			0.809		
SCC2			0.836		
SCC3			0.793		
SCC4			0.812		
CCA1				0.784	
CCA2				0.799	
CCA3				0.759	
CCA4				0.782	
SDGs1					0.780
SDGs2					0.954

Source: Field Data (2025)

Creative Abilities, and Children's Creative Abilities and SDG 4 Achievement were found to be significant, suggesting that these variables play a crucial role in explaining the overall research model.

The path coefficients presented in the model indicate both the direction and strength of the relationships. Teaching Method exerted a strong influence on Teacher Instruction, Teacher Instruction contributed positively to Children's Creative Abilities, while Children's Creative Abilities, in contrast, showed a negative effect on SDG 4 Achievement. These findings provide an important basis for further interpretation, suggesting that although teaching methods and teacher instruction can enhance children's creativity, translating that creativity into outcomes aligned with the SDGs requires the presence of additional supporting factors

3.1.1 Convergent Validity

The convergent validity test was conducted to evaluate the extent to which indicators of a construct measure the same concept and are highly correlated. According to (Hair et al., 2020) and Sarstedt et al. (2020), convergent validity is established when: 1)All outer loadings are ≥ 0.70; 2)The Average Variance Extracted (AVE) is ≥ 0.50. The results of the convergent validity assessment are presented in table 5.

Based on the results of the convergent validity test presented in Table 5, all indicators had loading factor values above 0.70, indicating that each item was able to represent its respective construct effectively. These high loading factor values suggest that the indicators in this model met the criteria for convergent validity. Therefore, all constructs can be considered convergently valid and are appropriate to proceed to the next stage of testing, namely discriminant validity and construct reliability.

3.1.2 Discriminant Validity

The convergent validity test was conducted to evaluate the extent to which indicators of a construct measure the same concept and are highly correlated. Table 6 shows that the diagonal values (in bold), representing the square roots of the AVE for each construct, are higher than the correlations between constructs in the corresponding rows and columns.

This indicates that each construct in the model possesses an adequate level of distinctiveness and does not measure the same concept as the other constructs. Therefore, the discriminant validity of the model can be considered empirically established and consistent with the criteria recommended by Sarstedt et al. (2020).

Table 6: Discriminant Validity Evaluation (Fornell–Larcker Criterion).

	Teaching Method (TM)	Teacher Interaction (TI)	Stimulation Childrens' Creativity (SCC)	Children Creative Abilities (CCA)	SDGs 4 Achie-vement (SDGs)
Teaching Method (TM)	0.834				
Teacher Interaction (TI)	0.800	0.810			
Stimulation Childrens' Creativity (SCC)	-0.100	-0.099	0.813		
SDGs 4 Achievement (SDGs)	-0.070	-0.049	0.088	0.871	
Children Creative Abilities (CCA)	0.089	0.151	-0.036	-0.151	0.781

Source: Field Data (2025)

3.1.3 Reliability

After establishing construct validity, the next step was to evaluate the internal reliability of each construct. Reliability was used to assess the consistency of the indicators in representing their intended constructs.

Referring to Sarstedt et al. (2020), internal reliability can be evaluated using three main indicators: Cronbach's Alpha, composite reliability (rho_a and rho_c), and average variance extracted (AVE). Cronbach's Alpha and composite reliability are considered adequate when their values exceed 0.70, while AVE is deemed acceptable for validity when it is greater than 0.50.

The discriminant validity test using the Fornell–Larcker criterion shows that the AVE square root (diagonal) for each construct is consistently higher than its correlations with other constructs. For instance, Teaching Method (0.834) and Teacher Interaction (0.810) both exceed their inter-construct correlations, as do SCC (0.813), CCA (0.781), and SDGs (0.871).

These findings confirm that the constructs in the model are distinct and valid, meaning each construct captures its own indicators more effectively than it overlaps with others. In short, the discriminant validity requirement is fulfilled, and the model is considered reliable for further analysis (Benitez et al., 2020).

Based on Table 7, all constructs in this study demonstrated excellent values for Cronbach's Alpha and Composite Reliability, both exceeding the minimum threshold of 0.70 (Ali et al., 2018; Hair et al., 2019). This indicates that each construct possesses a high level of internal consistency in measuring the intended concept.

In addition, the Average Variance Extracted (AVE) values for all constructs were above the cut-off point of 0.50, meaning that a substantial proportion of the variance in the indicators was explained by their respective latent constructs. These findings confirm that each indicator was able to meaningfully reflect its corresponding construct.

Therefore, it can be concluded that all constructs in the research model met the criteria for strong reliability and convergent validity, ensuring that the model results are credible, stable, and suitable for further testing in the structural analysis stage.

3.2 Inner Model

After the outer model evaluation produced satisfactory results, the next stage was to assess the inner model, or structural model, in order to evaluate the strength of the relationships among latent constructs and to test the research hypotheses. This analysis involved examining path coefficients, statistical significance (t-values and p-values) through bootstrapping, and the coefficient of determination (R^2) for each endogenous construct to assess the predictive accuracy of the model.

The purpose of the inner model assessment was to determine the extent to which the independent variables could explain the dependent variables in the model and to verify the theoretically proposed causal relationships (Hair et al., 2020). In addition, the analysis also considered potential mediation and moderation effects to identify intermediary or reinforcing roles among variables within the complex model structure. Furthermore, the adequacy of model fit was evaluated using global fit indices such as the Standardized Root Mean Square Residual (SRMR) and the Normed Fit Index (NFI) (Benitez et al., 2020).

3.2.1 Hypothesis Testing

Hypothesis testing in this study was conducted by examining the path coefficients, t-statistics, and p-values for each hypothesized relationship between the latent constructs. A hypothesis was considered statistically significant if the t-statistic was ≥ 1.96 and

the p-value ≤ 0.05 at the 95% confidence level (Hair et al., 2020). The path coefficients indicate the magnitude and direction of the relationships, while the t-statistics and p-values were used to determine statistical significance and the generalizability of the findings. The results of the hypothesis testing are summarized in Table 8.

Table 7: Construct Reliability.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Teaching Method (TM)	0.912	0.915	0.932	0.696
Teacher Interaction (TI)	0.895	0.900	0.919	0.656
Stimulation Childrens' Creativity (SCC)	0.832	0.846	0.886	0.661
Children Creative Abilities (CCA)	0.790	0.802	0.862	0.610
SDGs 4 Achievement (SDGs)	0.715	0.998	0.862	0.759

Source: Field Data (2025)

Table 8: Results of Hypothesis Testing and Structural Relationships.

Hypo-thesis	Path	Original Sample (O)	Sample Mean (M)	Standard Error	t-Statistic	p-Value	Decision
	Direct Effect						
H1	Teaching Method → Teacher Interaction	0.800	0.802	0.022	36.639	0.000	Accepted
H2	Teaching Method → Stimulation Children Creativity	-0.057	-0.053	0.120	0.473	0.636	Rejected
H3	Teaching Method → Children's Creative Abilities	-0.091	-0.093	0.102	0.891	0.373	Rejected
H4	Teaching Method → SDGs 4 Achievement	-0.097	-0.097	0.108	0.895	0.371	Rejected
H5	Teacher Interaction → Stimulation of Children's Creativity	-0.054	-0.064	0.117	0.462	0.644	Rejected
H6	Teacher Instruction → Children's Creative Abilities	-0.190	0.227	0.097	2.288	0.022	Accepted
H7	Teacher Instruction → SDGs 4 Achievement	0.051	0.053	0.120	0.421	0.673	Rejected
H8	Stimulation Children Creativity → Children's Creative Abilities	-0.023	-0.020	0.089	0.261	0.794	Rejected
H9	Stimulation Children Creativity → SDGs 4 Achievement	-0.150	-0.153	0.070	2.133	0.033	Accepted
	Modiating Effect						
H10	TM → SCC → CCA (Mediating)	0.001	0.001	0.011	0.121	0.904	Rejected
H11	TI → SCC → CCA (Mediating)	0.001	0.002	0.011	0.110	0.912	Rejected
H12	TM → SCC → SDGs (Mediating)	-0.043	-0.051	0.094	0.460	0.645	Rejected
H13	TI → SCC → SDGs (Mediating)	-0.033	-0.035	0.023	1.465	0.143	Rejected
H14	TM → CCA → SDGs (Mediating)	0.178	0.182	0.078	2.277	0.023	Accepted
H15	TI → CCA → SDGs (Mediating)	0.014	0.014	0.018	0.757	0.449	Rejected
H16	SCC → CCA → SDGs (Mediating)	-0.000	-0.000	0.001	0.105	0.916	Rejected

Notes:

- $p < 0.10$ (), $p < 0.05$ (), $\mathbf{p < 0.01}$ ().
- Hypothesis is supported if $t-$`statistic ≥ 1.96 at 5% significance level.`

Source: Field Data (2025)

Table 8 shows that most of the proposed hypotheses were not supported, with only a few significant paths identified. The significant relationships include *Teaching Method → Teacher Instruction (H1)*, *Teacher Instruction → Children's Creative Abilities (H6)*, *Stimulation Children Creativity → SDGs 4 Achievement (H9)*, as well as the mediating pathway *Teaching Method → Children's Creative Abilities → SDGs 4 Achievement (H14)*.

Meanwhile, the majority of both direct and indirect paths were rejected as they did not meet the required significance level. These findings provide empirical evidence that Teacher Instruction plays a crucial role in enhancing Children's Creative Abilities, which in turn influences the achievement of SDGs 4, albeit in a negative direction. Furthermore, the results demonstrate that Teaching Method exerts a strong indirect influence on SDGs through the mediating role of children's creativity.

3.2.2 R-Square

In addition to examining the significance of the relationships among constructs, the PLS-SEM analysis also assessed the model's predictive power for the endogenous variables through the R-Square (R^2) values. R^2 reflects the proportion of variance in a dependent construct that can be explained by the independent constructs within the model. An R^2 value of 0.75 is considered substantial, 0.50 is viewed as moderate, and 0.25 is regarded as weak, depending on the context of the research discipline (Ali et al., 2018; Hair et al., 2019).

Table 9: R-square Value.

Konstruk Endogen	R-Square	Adjusted R-Square
Children Creative Abilities	0.026	0.017
SDGs 4 Achievement	0.027	0.017
Stimulation Children Creativity	0.011	0.004
Teacher INteraction	0.640	0.639

Source: Field Data (2025)

Table 9 indicates that the explanatory power of the model varies considerably across constructs. The highest R^2 value is found in Teacher Interaction (R^2 = 0.640; Adjusted R^2 = 0.639), suggesting that more than 60% of the variance in teacher–student interaction can be explained by the predictors included in the model. This result reflects strong predictive power and highlights Teacher Interaction as a central construct within the framework.

In contrast, the R^2 values for Children Creative Abilities (0.026), SDGs 4 Achievement (0.027), and Stimulation of Children's Creativity (0.011) are notably low, indicating that the predictors account for only a very small proportion of the variance in these constructs. These findings imply that additional factors, not captured in the current model, may play a more substantial role in explaining creativity-related outcomes and SDG achievements.

Overall, the results demonstrate that while the model explains Teacher Interaction effectively, its predictive ability for creativity and achievement-related constructs remains limited. This suggests the need for model refinement, possibly through the inclusion of other mediating or moderating variables, to better capture the dynamics underlying children's creativity and educational outcomes.

4 DISCUSSION

The results of this study revealed that teaching method has a strong and significant effect on teacher instruction (H1). This finding underscores the importance of pedagogical strategies in shaping the quality of classroom interaction. When teachers employ active and student-centered methods, they tend to be more engaged in reciprocal communication, feedback provision, and instructional responsiveness. Active methodologies significantly enhance both teacher-student engagement and the integration of sustainability values in learning (Crisol-Moya et al., 2020; Tang, 2023; L. Zhang et al., 2021). This suggests that teaching approaches do not merely transfer knowledge but also determine how effectively teachers can interact with learners.

Interestingly, the direct effects of teaching method on the stimulation of children's creativity, children's creative abilities, and SDGs achievement (H2–H4) were not supported. This indicates that teaching methods alone are insufficient to directly foster creativity or sustainable development competencies. Rather, their influence is more indirect, requiring mediating mechanisms. This aligns with the argument of Beghetto & Kaufman (2014), who emphasized that creativity development is contingent not only on teaching practices but also on the broader classroom climate, emotional support, and opportunities for exploration. Hence, the lack of direct influence found in this study may reflect the limited focus of teaching practices that still prioritize knowledge transmission over creativity-oriented learning.

Another surprising finding lies in the relationship between teacher instruction and children's creative abilities (H6), which was found to be significant but negative. In other words, the more intensive the instruction, the lower the creative abilities of children. This resonates with Hennessey, (2019) classic theory of creativity, which suggests that controlling or overly directive environments undermine intrinsic motivation and creative performance. Recent studies reinforce this perspective; for example, Zhang et al. (2023) reported that children's creativity flourishes when they experience supportive peer relationships and a sense of belonging in the classroom, rather than strict instructional control. Thus, the negative effect observed in this study highlights the potential risks of rigid teacher instruction that limits children's autonomy.

Furthermore, the effect of stimulation of children's creativity on SDGs achievement (H9) was also significant but negative. This unexpected outcome suggests that excessive or poorly targeted stimulation may distract from broader sustainable development goals. As López et al., (2024) argue in their systematic review, creativity in education contributes positively to sustainability only when it is contextually integrated and aligned with ecosocial perspectives. Without such alignment, creative activities may remain isolated and fail to translate into meaningful contributions toward sustainability outcomes.

Regarding the mediation hypotheses, most pathways through stimulation of creativity (H10–H13) and children's creative abilities (H15–H16) were not significant. However, one important mediating effect was confirmed: teaching method influences SDGs achievement through children's creative abilities (H14). This finding positions of creativity as a crucial bridge between pedagogy and sustainability. It also supports UNESCO's (2021) framework, which highlights creativity and innovation as central competencies for sustainable development. Recent studies echo this, showing that problem-solving pedagogies and creative risk-taking in classrooms foster both individual growth and collective contributions to global goals (Creely et al., 2021; Fischer et al., 2022; Henriksen et al., 2021).

Taken together, the findings suggest that while teaching methods play a pivotal role in shaping teacher instruction, their contribution to creativity and sustainability is indirect and contingent upon how creativity is cultivated within the classroom. Overly rigid instruction can stifle creativity, while unstructured stimulation may fail to support sustainability. The most promising pathway, as demonstrated in this study, lies in empowering children's creative abilities as mediators linking teaching practices to sustainable educational outcomes. This insight resonates with a growing body of literature emphasizing the need for integrative pedagogies that balance structure with autonomy and align creative development with the broader aims of sustainable development.

5 CONCLUSIONS

This study examined the complex relationships between teaching method, teacher instruction, children's creativity, and the achievement of SDG 4, and the findings offer several important insights. The results confirm that teaching method plays a decisive role in strengthening teacher instruction, yet its direct impact on creativity and sustainability outcomes was limited, suggesting that pedagogy influences these aspects mainly through indirect pathways.

Notably, the study revealed that intensive teacher instruction can negatively affect children's creative abilities, while excessive or unfocused stimulation of creativity may even reduce progress toward SDG 4, highlighting the need for more balanced and contextually integrated approaches. At the same time, the mediation analysis demonstrated that teaching methods can contribute positively to SDGs 4 achievement when they enhance children's creative abilities, positioning creativity as a vital bridge between classroom practice and sustainable development.

These findings imply that educational strategies should move beyond rigid instruction and prioritize learning environments that cultivate autonomy, exploration, and problem-solving skills, as these elements are central to preparing students for future challenges.

For future research, it is essential to broaden the model by including variables such as school climate, peer collaboration, digital pedagogy, and socio-emotional support, as well as adopting longitudinal or qualitative approaches to capture how creativity and sustainability evolve over time, thereby generating a deeper and more comprehensive understanding of how pedagogy can effectively support sustainable education.

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