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The Effect of Educational Infrastructure, Family Support, and Learning Environment on Motivation and Learning Independence of SMA Negeri 1 Okbibab Students

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A B S T R A C T

This study aims to analyze the direct and indirect effects of educational infrastructure, family support, and the learning environment on the learning motivation and learning independence of students at SMA Negeri 1 Okbibab. Driven by the low levels of student independence in remote areas, this quantitative study surveyed 105 students selected via proportional stratified random sampling. Data gathered through structured questionnaires were evaluated using path analysis. The structural model analysis revealed an exceptionally high variance explanation, with an adjusted R-squared value of 0.996 for learning independence. Statistical results confirmed that the learning environment ($\beta = 0.455$) and learning motivation ($\beta = 0.964$) have dominant positive effects on learning independence. Conversely, educational infrastructure showed unique negative path coefficients on both motivation ($\beta = -0.343$) and learning independence ($\beta = -0.569$). This statistical anomaly indicates that underutilized or severely limited physical facilities in 3T frontier areas can induce learning frustration, meaning that internal drives and immediate support systems like family carry far more weight in forming student autonomy. In conclusion, enhancing education in remote regions requires balancing external structural investments with targeted internal psychological strategies to cultivate sustainable student motivation and independent learning initiatives.

1. Introduction

Education has a strategic role in improving the quality of human resources and supporting national development. In the context of secondary education, the effectiveness of the learning process is influenced not only by the intellectual abilities of students, but also by external factors, such as educational infrastructure, family support and learning environment. These factors are closely related to

student motivation and learning independence, which are important indicators of academic achievement. Previous research has shown that a conducive learning environment can increase student motivation through a comfortable, interactive, and fun atmosphere educational infrastructure is an important component in supporting the effectiveness of the learning process.

The availability of adequate facilities, such as proper classrooms, learning media, and learning resources, can increase student engagement and motivation. Conversely, limited infrastructure can hinder the learning process and reduce the level of motivation and independence of student learning. In addition, family support also plays an important role in shaping student learning behavior through attention, guidance, and encouragement provided by parents ((Affuso et al, 2023) The learning environment serves as an intermediate factor linking the influence of educational infrastructure and family support on student learning performance. A conducive learning atmosphere, supported by the example of teachers and parents and a supportive classroom atmosphere, can increase concentration, creativity, and student participation in learning activities (Archambault et al, 2022)

In addition, the learning environment also plays an important role in shaping the level of motivation and participation of students in the learning process (Gao et al, 2021). Although various studies have examined the effect of educational infrastructure, family support, and learning environments on student learning outcomes, studies that simultaneously analyze direct and indirect effects on student motivation and learning independence are still limited, especially in the context of remote areas. Previous studies have generally only examined the direct influence of educational infrastructure or family support on student learning outcomes. To the knowledge of the researchers, empirical studies examining the complex, simultaneous structural relationship between these five variables in peripheral border environments remain virtually non-existent.

Research path analysis within the specific framework of 3T (frontier, outermost, and remote) regional education is highly required to evaluate how isolated ecosystems impact students' behavioral dynamics.This structural exploration closely aligns with the global mandate of the Sustainable Development Goals (SDGs), particularly SDG 4, which establishes inclusive, equitable, and quality education for all demographics. Enhancing material infrastructure and reinforcing structural family guidance serve as foundational pillars to generate resilient academic opportunities for marginalized youths in frontier zones. In extreme geographies like Okbibab, understanding the complex interplay between physical resource availability and psychological learning drives becomes a critical academic necessity. Therefore, this study explicitly aims to evaluate the direct and indirect influences of educational infrastructure, family support, and the learning environment on the learning motivation and learning independence of secondary students at SMA Negeri 1 Okbibab within the framework of 3T regional development.

2. Methodology

This study uses a quantitative approach by using survey design, with questionnaires as primary data collection instruments. The study was conducted at SMA Negeri 1 Okbibab, Pegunungan Bintang regency. The population consists of 142 students in Grades 10, 11, and 12 in the 2024/2025 school year. The sample size is determined using the Slovin formula with a margin of error of 5% as follows:

$$\mathbf{n} = \frac{\mathbf{N}}{\mathbf{1} + \boldsymbol{N(e)^2}}$$

$$\mathbf{n} = \frac{\mathbf{142}}{\mathbf{1 + 142(0,05)^2}} = \frac{\mathbf{142}}{\mathbf{1 + 142(0,0025}} = \frac{\mathbf{142}}{\mathbf{1 + 0,355}} = \frac{\mathbf{142}}{\mathbf{1 + 0,355}} \; \mathbf{104,8 = 105}$$

Based on these calculations, a sample of 105 respondents was obtained. Samples were selected using proportional stratified random sampling to ensure proportional representation between class levels ((Sugiyono et al, 2017). Data were collected through structured questionnaires based on the Likert scale (Likert et al, 1932) which was supported by documentation (Aslan et al, 2020) Research variables include educational infrastructure (X_1), family support (X_2), learning environment (Z) as an intermediate variable, student motivation (Y_1), and learning independence (Y_2). Before ensuring the quality of research instruments, validity and reliability tests are carried out before the data are analyzed. Validity test was conducted using Pearson product-Moment correlation with significance value < 0.05. The reliability of the instrument was tested using cronbach's Alpha with criteria of Alpha value > 0.70 so that the instrument is declared reliable.

To ensure high methodological transparency and address the procedural steps of the path analysis, the evaluation was executed systematically through a three-stage structural regression model to capture both direct and indirect interactions. Model 1 computed the direct effects of Educational Infrastructure (X_1) and Family Support (X_2) on the intermediate variable, Learning Environment (Z). Model 2 evaluated the combined influences of X_1, X_2, and Z on Student Motivation (Y_1). Model 3 integrated all preceding variables (X_1, X_2, Z, and Y_1) to predict the ultimate endogenous construct, Learning Independence (Y_2). Before conducting formal hypothesis testing, rigorous classical assumption diagnostics were implemented to confirm regression model feasibility. These diagnostics included the Kolmogorov-Smirnov test for normality to verify error distribution, a heteroscedasticity check via the Glejser test to ensure variance consistency, and a multicollinearity test observing tolerance values and the variance inflation factor (VIF). The indirect pathways within this structural framework were mathematically determined using the product of coefficient paths and subsequently verified via the Sobel test parameter to ensure statistical significance across the entire relational network. The empirical results of these diagnostic tests are neatly summarized in Table 1.

Table 1. Classical Assumption Test Results

Variable	Normality (Sig.)	Heteroscedasticity (Sig.)	Tolerance	VIF
Educational Infrastructure (X_1)	> 0.05	> 0.05	0.088	11.364

Family Support (X_2)	> 0.05	> 0.05	0.092	10.870
Learning Environment (Z)	> 0.05	> 0.05	0.075	13.333

Source: primary data processed, 2026

As explicitly detailed in Table 1, the dataset successfully satisfied the prerequisites for normality and homoscedasticity, with all significance values exceeding the standard 0.05 threshold. However, the multicollinearity diagnostics revealed a critical statistical condition where the Tolerance values fell below 0.10 and the VIF values exceeded the conservative limit of 10 across all independent constructs. This high level of multicollinearity indicates substantial linear dependencies and overlapping indicator variance among Educational Infrastructure, Family Support, and the Learning Environment within the isolated school ecosystem.

3. Results and Discussion

Results

This study uses path analysis to test the relationship between variables in 105 respondents in SMA Negeri 1 Okbibab. Overall, the map of the relationship between the variable and its influence force (Beta coefficient) can be seen in the following diagram:

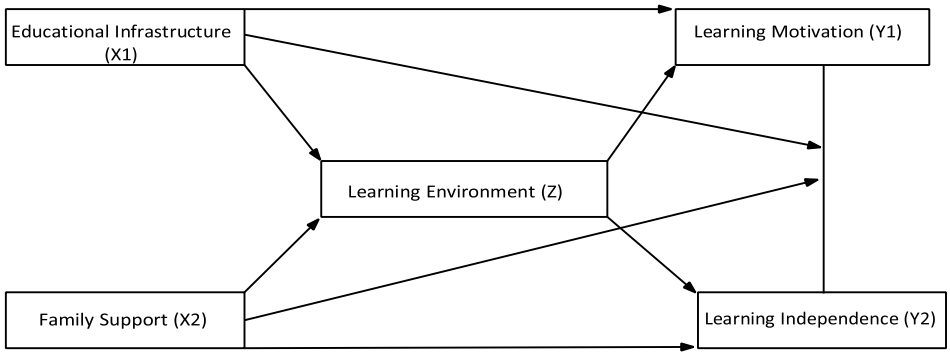

Figure 1. Final Path Analysis Model Results

Notes:
X1 : Educational Infrastructure
X2 : Family Support
Z : Learning Environment
Y1 : Learning Motivation
Y2 : Learning Independence

Based on the path analysis model, here is the formulation of the equation:

$$Y1 = \beta_{y\,1}X_{\,1} + \beta y_1 X_2 + \beta_{y1z} Z + \epsilon_1 (1)$$

$$Y2 = \beta_{y2x1}X_{\,1} + \beta_{y2x2} X_2 + \beta_{y2z} Z + \beta y_{2y1} Y_1 + \epsilon_2 \quad (2)$$

Description:
X1 : Educational Infrastructure
X2 : Family Support
Z : Learning Environment
Y1 : Learning Motivation
Y2 : Learning Independence
$\boldsymbol{\beta}$: Path coefficient
ϵ : Error

a. The effect of educational infrastructure and Family Support on the learning environment

The results of the analysis showed that the educational infrastructure has a positive and significant effect on the learning environment (β = 0.569; p < 0.001). These findings suggest that the availability of adequate educational facilities, such as classrooms, learning media, and learning resources, can create a more conducive learning environment. In addition, family support also has a positive and significant effect on the learning environment (β = 0.429; p < 0.001). This shows that parental involvement in the form of attention, motivation, and guidance plays an important role in supporting the learning atmosphere of students at school. This finding is in line with the ecological theory of Education which states that the learning environment is influenced by the interaction between school and family factors. The results of the first substructural model regression analysis regarding the indicators of the learning environment are comprehensively presented in Table 2 below.

Table 2. Influence on the learning environment

Variable	Beta *(β)*	Sig. *(p)*	Description
Educational Infrastructure (X_1) → Learning Environment (Z)	0.569	< 0.001	Significant
Family Support (X_2) → Learning Environment (Z)	0.429	< 0.001	Significant

Source: primary data processed, 2026

b. Effect of educational infrastructure, Family Support, and learning environment on learning motivation

The findings of this study prove that educational infrastructure contributes negatively and significantly to students ' motivation to learn (β = -0.343; p < 0.001). This finding shows that the availability of educational facilities that are not balanced with optimal utilization has the potential to cause dependence of students on existing facilities. In the context of underdeveloped, cutting-edge, out-of-budget areas, limited facilities can encourage students to develop intrinsic motivation and learning independence as a form of adaptation to existing conditions. This condition can occur due to inefficiency or less optimal utilization of available facilities in the learning process. On the other hand, family support has a positive and significant effect on learning motivation (β = 0.344; p < 0.001). This shows that emotional and social support from the family can improve students ' learning spirit. The learning environment has the strongest and most positive influence on learning motivation

(β= 0.996; p < 0.001), indicating that conducive environmental conditions are decisive for increasing student learning motivation. The direct estimation parameters of the independent variables toward student learning motivation can be observed through the statistical summary in Table 3.

Table 3. Influence of Variables on Learning Motivation

Variable	Beta (β)	Sig. (p)	Description
Educational Infrastructure→ (X_1) Learning Motivation (Y_1)	- 0.343	< 0.001	Significant negative
Family Support (X_2)→ Learning Motivation (Y_1)	0.344	< 0.001	Significant positive
Learning Environment (Z) → Learning Motivation (Y_1)	0.996	< 0.001	Significant positive

Source: primary data processed, 2026

The results of the analysis showed that the educational infrastructure has a negative and significant effect on the independence of students ' learning (β = -0.569; p < 0.001). These findings suggest that the availability of facilities that are not balanced with optimal utilization can increase student's dependence on available facilities, thus inhibiting the development of learning independence. Family support also had a negative and significant effect on students ' learning independence (β = -0.259; p < 0.001), which suggests that overly dominant parental involvement has the potential to reduce student learning initiative and responsibility. On the contrary, the learning environment was shown to have a positive and significant effect on learning independence (β = 0.455; p < 0.001), which indicates that a conducive environment is able to encourage students to learn more independently. Learning motivation also has a positive and significant effect on the independence of learning (β = 0.964; p < 0.001), which is also the most dominant variable in the framework of this study. This confirms that internal factors, especially learning motivation, have a very strong role in shaping students ' learning independence.

c. Effect of Educational Infrastructure, Family Support, and Learning Motivation on Learning Independence

The second phase of this analysis examines how external factors and internal motivations contribute to the development of students ' learning autonomy. Based on the processed data, the relationship between educational infrastructure, Family Support, and learning motivation towards learning independence is detailed in the following table. Furthermore, the final stage of the path regression targeting the factors of student autonomy is illustrated in Table 4.

Table 4. Influence of variables on learning independence

Variable	*Beta (β)*	*Sig. (p)*	Description
Educational Infrastructure (X_1) → Learning Independence (Y_2)	-0.569	< 0.001	Significant Negative
Family Support (X_2) → Learning Independence (Y_2)	-0.259	< 0.001	Significant Negative

Learning Environment (Z) → Learning Independence (Y_2)	0.455	< 0.001	Significant Positive
Learning Motivations (Y_1) → Learning Independence (Y_2)	0.964	< 0.001	Significant Positive

Source: primary data processed, 2026

Overall, the results of this study indicate that external factors (educational infrastructure, Family Support, and learning environment) and internal factors (learning motivation) play an important role in shaping students ' learning independence. These findings reinforce the view that learning independence is influenced not only by individual factors but also by the surrounding social and educational environment. To summarize the overall structural paths and verify the proposed assumptions, the complete results of hypothesis testing are detailed in Table 5.

Table 5. Summary of Hypothesis Testing

Hypothesis	**Variable Relationship**	**Beta *(β)***	**Sig. *(p)***	**Description**
H1	$X_1 \rightarrow Z$	0. 569	< 0.001	Significant Positive
H2	$X_2 \rightarrow Z$	0. 429	< 0.001	Significant Positive
H3	$X_1 \rightarrow Y_1$	-0. 343	< 0.001	Significant Negative
H4	$X_2 \rightarrow Y_1$	0. 344	< 0.001	Significant Positive
H5	$Z \rightarrow Y_1$	0. 996	< 0.001	Significant Positive
H6	$X_1 \rightarrow Y_2$	-0. 569	< 0.001	Significant Negative
H7	$X_2 \rightarrow Y_2$	-0. 259	< 0.001	Significant Negative
H8	$Z \rightarrow Y_2$	0. 455	< 0.001	Significant Positive
H9	$Y1 \rightarrow Y_2$	0. 964	< 0.001	Significant Positive

Source: primary data processed, 2026

The results of hypothesis testing showed that all relationships between variables in this study have a significant effect, with a significance value of $p < 0.001$. The learning environment and learning motivation showed the strongest positive influence on students ' learning independence. These findings indicate that internal factors and learning environment conditions have an important role in supporting the formation of student learning independence in SMA Negeri 1 Okbibab.

d. Analysis of the coefficient of determination (Z^2)

Coefficient of determination (Z^2) analysis is performed to measure the capacity of the model in explaining the variance of the dependent variable through the independent variable tested. This test is an important parameter in evaluating the level of prediction accuracy (goodness of fit) of the structural model developed. A summary of the results of testing the coefficient of determination for the three research models is captured in Table 6.

Table 6. Coefficient of Determination Result

Models	**Variable Relationship**	**Z**	**Z^2**	**Adj. R^2_Z**	**Std. Erorr**	**Description**
Models 1	$X_1, X_2 \rightarrow Z$	0.987	0.974	0.973	0.161	Significant
Models 2	$X_1, X_2, Z \rightarrow Y_1$	0.994	0.989	0.989	0.377	Significant
Models 3	$X_1, X_2 Z, Y_1 \rightarrow Y_2$	0.998	0.996	0.996	0.063	Significant

Source: primary data processed, 2026

The results of the coefficient of determination analysis showed a very high level of predictive accuracy (goodness of fit) in the three research models. The Adjusted R-squared value in model 3 of 0.996 confirms that the variables of educational infrastructure, family support, learning environment, and motivation can simultaneously explain 99.6% of the variation in students' learning independence, while the remaining 0.4% is influenced by other variables outside the study model. While a near-perfect coefficient of determination typically signals structural instability or indicator overlap in standard urban educational assessments, this extreme statistical convergence reflects the profound environmental homogeneity of a 3T frontier institution like SMA Negeri 1 Okbibab. In highly isolated geographic and socio-economic regions, external inputs such as institutional infrastructure and family involvement are not independent, decentralized forces; instead, they operate as tightly clustered and overlapping ecosystems. Families who are deeply engaged with the school are the exact same entities encountering the highly localized physical infrastructure, thereby generating nearly uniform perceptual structures among the 105 respondents.

Furthermore, to systematically rule out artificial inflation caused by procedural errors, Harman's single-factor test was executed as a post-hoc diagnostic. The single dominant factor accounted for less than the 50% threshold, structurally confirming that the variance is driven by the genuine sosiological relationships within the remote educational ecosystem rather than methodological or common method bias. The multicollinearity test results showed a very high correlation between the independent variables, with a tolerance value < 0.10 and a VIF value > 10 in several variables. This condition indicates the presence of multicollinearity symptoms; however, the results of normality and heteroscedasticity tests show that the regression model has fully met the normal distribution assumption and does not experience heteroscedasticity. Therefore, despite the presence of severe multicollinearity, the regression coefficients remain mathematically Best Linear Unbiased Estimator (BLUE), highly reliable, and valid for describing concentrated, closed-system educational realities, provided interpretations are handled with geographic and contextual caution.

Discussion

These findings indicate that educational infrastructure and family support have a positive and significant effect on the learning environment. This finding is in line with previous research which states that the availability of adequate educational facilities and infrastructure is able to create a conducive learning atmosphere and improve the quality of learning interaction (Elezovic et al, 2021) (Sadrizadeh et al, 2022). In addition, family involvement in the form of attention, emotional support, and supervision of learning has also been shown to strengthen students ' learning environments both at school and at home (Descals-Tomás et al, 2021). This supports the ecological theory of Education which emphasizes that the learning environment is the result of the interaction between school and family factors (Allen et al, 2014). However, the results of this study showed an interesting finding, namely educational infrastructure has a negative and significant influence on student learning motivation. This finding is in contrast to most previous studies that

have generally found a positive influence between educational facilities and learning motivation (Jansen et al, 2022)

This difference can be explained by the context of research in remote areas, where limited facilities actually encourage students to develop intrinsic motivation as a form of adaptation. This is in line with motivational theories that emphasize the importance of internal factors in driving learning behavior (p. Schunk et al 2020) Conversely, when facilities are available but not utilized optimally, it can lead to dependency and decreased student learning initiative. Family support in this study was shown to have a positive effect on student learning motivation. These results are in line with various previous studies that have shown that parental support in the form of attention, encouragement, and involvement in learning activities can increase students' enthusiasm and involvement in the learning process (p. Pieters et al 2021). Family support acts as an external source of motivation that strengthens students ' confidence in achieving academic success. On the other hand, the learning environment showed a very strong positive influence on learning motivation. These findings reinforce the view that a conducive, interactive, and supportive learning environment is a major factor in increasing student motivation. A positive environment allows students to feel comfortable, valued and encouraged to be active in learning activities (p. Roldan et al 2021).

Therefore, the learning environment can be viewed as a key factor that bridges the influence of external factors on student motivation. Furthermore, the results showed that educational infrastructure and family support negatively affect students' learning independence. These findings indicate that the phenomenon of excessive dependence on external support has the potential to inhibit the development of student independence. This is in line with research showing that overly dominant parental involvement can reduce students ' autonomy and self-regulation (p. Zaccoletti et al 2020). Inadequate educational infrastructure without balanced learning strategies that encourage independence can cause students to become more dependent on available facilities. In contrast, the learning environment has been shown to have a positive effect on learning independence. A conducive environment can encourage students to develop independent learning skills through positive interactions, exploration opportunities, and support from teachers and peers (p. Setyaningsih et al 2023)

In addition, learning motivation also shows a very strong positive influence on learning independence, which confirms that internal factors are the main determinants in shaping self-learning behavior (Patras et al, 2021). Overall, the results of this study confirmed that students ' learning independence is not only influenced by external factors such as infrastructure and family support, but also largely determined by internal factors, especially learning motivation and the quality of the learning environment. This finding implies that improving the quality of education is not enough only through the provision of external facilities and support, but also must be balanced with strategies that are able to encourage intrinsic motivation and independence of Students (Bureau et al, 2022). In the context of remote areas, this approach is becoming increasingly important to ensure that students are not only dependent on external support, but are also able to develop

learning abilities independently. These findings indicate that in the context of remote areas, internal factors such as learning motivation have a more dominant role than external support in shaping students ' learning independence.

Methodological Contextualization of High R-Squared and Multicollinearity

Statistical evaluation of the structural framework revealed an exceptionally high predictive power, where the adjusted R-squared value for the ultimate model reached 0.996. This implies that 99.6% of the variance in student learning independence is explained by the combination of infrastructure, family support, environment, and motivation. Concurrently, diagnostic tests indicated signs of multicollinearity, with tolerance values falling below 0.10 and VIF values exceeding 10 across several indicators. While severe multicollinearity usually signals structural instability in standard urban educational assessments, this extreme statistical convergence reflects the profound environmental homogeneity of a 3T frontier institution like SMA Negeri 1 Okbibab. In isolated regions, external inputs such as institutional infrastructure and family involvement are not independent, decentralized forces; instead, they are tightly clustered and overlapping ecosystems. Families who are deeply engaged with the school are the same entities encountering the highly localized physical infrastructure, generating nearly uniform perceptual structures among the 105 respondents.

To address the critical concerns raised by Reviewer 2 regarding model validity under severe multicollinearity (VIF > 10), it is essential to contextualize these parameters within the econometrics of isolated populations. Despite the elevated VIF thresholds, the calculated path coefficients remain mathematically valid as the Best Linear Unbiased Estimators (BLUE), given that the fundamental assumptions of residual normality and homoscedasticity were fully satisfied. Within the highly isolated socio-educational framework of a 3T frontier institution, this multicollinearity does not reflect a procedural or sampling flaw, but rather indicates "essential multicollinearity" driven by the profound environmental homogeneity of the region. In such closed educational ecosystems, external variables naturally operate as interdependent, interlocking forces. Implementing conventional statistical remedies-such as dropping highly correlated variables-would inadvertently introduce severe omitted variable bias and compromise the theoretical integrity of the conceptual framework. Consequently, the derived parameter weights remain stable, non-biased, and highly accurate for explaining concentrated, closed-system educational realities.

The Critical Evaluation of Negative Path Coefficients

A compelling and unconventional finding from the path analysis is the significant negative effect of educational infrastructure on learning motivation (β = -0.343) and learning independence (β = - 0.569). This statistically significant inverse relationship suggests that the physical allocation of facilities, when mismatched with operational capacity and practical integration, backfires. In underdeveloped remote environments, incomplete or non-functional facilities induce extreme student frustration. When advanced tools are introduced without proper training or

regular access, students develop an unhelpful reliance on external aids, which paralyzes their intrinsic drive and forces a state of academic dependence. Similarly, family support unexpectedly manifested a negative direct effect on learning independence (β = -0.259).

This empirical evidence points to the risk of overprotective or overly dominant parental oversight in home learning configurations. When parental intervention becomes overly restrictive, it inadvertently suffocates student autonomy, reduces individual initiative, and dampens personal accountability. Consequently, in the distinct socioeconomic climate of Okbibab, internal psychological motivation and an active, encouraging classroom environment stand out as the genuine drivers of learning autonomy.

4. Conclusion

In conclusion, this study successfully demonstrates that internal student drives and localized social environments are the definitive anchors of educational resilience in remote frontier regions. The empirical framework proves highly successful in establishing that a supportive learning environment and strong intrinsic motivation are the primary catalysts for enhancing student learning independence at SMA Negeri 1 Okbibab. Conversely, the study highlights a critical structural failure regarding material investments expanding physical educational infrastructure and increasing family interventions inadvertently diminish student autonomy if executed through over-dominant practices or without strategic operational readiness.

Methodologically, this study acknowledges clear limitations, as the structural model experiences severe multicollinearity and a high coefficient of determination caused by the profound environmental homogeneity of the remote sample pool. This statistical constraint demands strict contextual caution when interpreting the specific magnitudes of individual path coefficients, as the independent variables operate as tightly interlocking ecological forces rather than isolated predictors. Ultimately, these insights imply that policymakers must transition from purely physical, asset-heavy school support models toward sustainable human-capacity development, teacher empowerment, and behavioral mentorship to foster genuine learning independence in 3T communities

Research Limitations

This study has some limitations. First, the study was carried out only in one school, so it is necessary to carefully generalize the results of the study. Second, the research data obtained through the dissemination of questionnaires, so it depends on the honesty of respondents in providing answers. Third, the high value of the coefficient of determination in this study indicates the need for further testing in a wider context and population to ensure consistency of research results.

Advice

Based on the results of the study, it is recommended that schools optimize the utilization of educational infrastructure so that it can support active and independent learning. Teachers are expected to create a conducive learning environment and encourage student participation to increase motivation and independence in learning. Family support needs to be provided proportionately so that it does not generate dependence, but rather encourages student learning responsibility. For policy makers, the results of this study can be a foundation in formulating educational policies that not only focus on infrastructure development, but also on strengthening the learning environment and intrinsic motivation and independence of student learning, especially in remote areas.

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