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The Influence of Subjective Well-Being and Learning Motivation on Mathematics Learning Outcomes in 10th Grade at SMA Negeri 11 Samarinda

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Abstract
Indonesian students continue to face difficulties in mathematics, as reflected in their low PISA performance. Besides cognitive mastery, non-cognitive factors such as Subjective Well-Being (SWB) and learning motivation also play an important role in shaping students' academic outcomes. However, previous findings regarding the influence of SWB on achievement have been inconsistent, suggesting the need to examine it alongside other psychological factors. This study investigates the influence of SWB and learning motivation on the mathematics learning outcomes of 10th-grade students at SMA Negeri 11 Samarinda. A quantitative causal-comparative design was used with three randomly selected classes as the sample. SWB and learning motivation data were collected using a Likert-scale questionnaire, while mathematics outcomes were obtained from students' report cards. The data were analyzed using truncated spline nonparametric regression. The results indicate that both SWB and learning motivation significantly affect mathematics learning outcomes, individually and simultaneously. These findings highlight the importance of supporting students' psychological well-being and motivation to enhance mathematics achievement at the senior high school level.
Keywords: Subjective Well-Being; Learning Motivation; Mathematics Learning Outcomes

1. Introduction

Mathematics achievement in Indonesia remains a significant concern, as reflected in the country's low performance in the Programme for International Student Assessment (PISA). Recent findings show that Indonesian students achieved an average score of 366 in mathematics, with only about 18% reaching at least Level 2, the minimum proficiency benchmark set by the OECD (OECD, 2023; Wijaya et al., 2024; Yanto & Rahaju, 2024; Putra et al., 2024). These results indicate that many students struggle not only with mathematical concepts but also with factors influencing their readiness and engagement in learning.

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While instructional quality and cognitive mastery are often emphasized, psychological variables such as Subjective Well-Being (SWB) and learning motivation have increasingly been recognized for their roles in shaping students' academic performance (Park et al., 2023; Çiftçi & Yıldız, 2019; Madigan & Curran, 2021). SWB, which encompasses individuals' evaluations of their life satisfaction as well as their experiences of positive and negative emotions, is thought to influence how students respond to academic demands and pressures. Students who experience higher levels of well-being tend to regulate their emotions more effectively, cope better with stress, and sustain their engagement in the learning process (Wang, 2025; Das et al., 2020). These psychological advantages may, in turn, support more effective participation in classroom activities and create conditions that are conducive to learning.

However, empirical findings regarding the relationship between SWB and academic achievement remain inconsistent across studies. Several studies report that SWB is positively associated with academic performance, although the strength of this relationship tends to be relatively weak (Purwanti et al., 2023; Maryanti et al., 2021). These findings indicate that while students with higher well-being may demonstrate slightly better learning outcomes, the influence of SWB is not strong enough to be considered a dominant factor. In contrast, other studies have found very small or even non-significant associations between SWB and academic achievement (Zakiyah, 2020), suggesting that SWB does not consistently translate into measurable improvements in students' performance. These variations imply that SWB alone may not be a strong predictor of academic achievement, and its influence may vary depending on the learning context, student characteristics, and the environmental conditions in which learning takes place.

Learning motivation, on the other hand, consistently emerges as a strong predictor of academic achievement. Motivated students tend to be more persistent, have clearer learning goals, and show greater effort when facing academic challenges (Hard & Indrawati, 2024; Ruhma & Ni'mah, 2024 ; Nurrawi et al., 2023). Learning motivation has also been shown to be positively related to student engagement and performance in various learning contexts (Zhao

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et al., 2024; Passeggia et al., 2023). However, research examining learning motivation and subjective well-being (SWB) as two independent factors influencing mathematics achievement, especially at the high school level in Indonesia, is still limited. Most existing studies focus on only one of these variables at a time, resulting in a lack of empirical evidence to describe how each factor contributes separately to students' mathematics learning outcomes in the same analytical model. Therefore, analyzing SWB and learning motivation as separate predictors is crucial to gaining a clearer understanding of the psychological factors associated with students' mathematics achievement.

Despite these insights, limited studies in Indonesia have examined SWB and learning motivation simultaneously in relation to mathematics learning outcomes at the senior high school level. Most existing research focuses on the pandemic context, middle school populations, or examines these variables separately. As such, there is a clear research gap in understanding how these two psychological factors jointly contribute to mathematics achievement in a normal learning environment.

Therefore, this study aims to analyze the influence of Subjective Well-Being and learning motivation on the mathematics learning outcomes of 10th-grade students at SMA Negeri 11 Samarinda. By addressing inconsistent findings in previous studies and examining both variables together, this research seeks to provide a deeper understanding of the psychological factors that shape mathematics performance in Indonesian high schools.

2. Method

The method used in this study is casual-comparative research using a quantitative approach. Causal-comparative research is a type of research that tested a hypothesis about the cause-and-effect relationship of several variables. This research can be utilized to test whether a variable has an effect on other variables, and it can be used to determine the relative contributions of predictor variables to the existence of response variables (Rahmi et al., 2023). In this context, this study aims to gather data in order to test if there are influence between predictor variables on the response variable. This study includes three variables: Subjective

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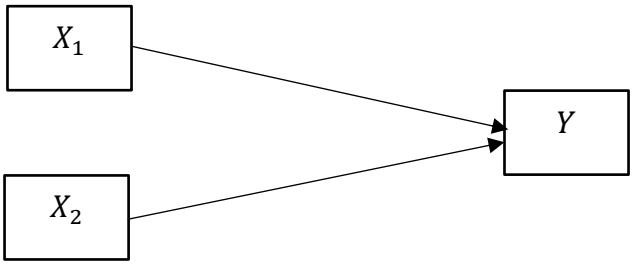
Well-Being (X_1), Learning Motivation (X_2), and Mathematics Learning Outcome (Y). The research image design as follows:

Figure 1 Causal-Comparative Research Design



This study is conducted in the 2024/2025 academic year at SMA Negeri 11 Samarinda. The population in this study consists of six classes of 10th grade in SMA Negeri 11 Samarinda and the sample is determined using random sampling. The final sample consisted of three randomly selected classes with a total of 110 students.

The research instrument is a questionnaire using a Likert scale to measure the two predictor variables Subjective Well-Being (Life Satisfaction and Positive/Negative Effects) and Learning Motivation (Desire to Study).

The SWB instrument consisted of two components: the Life Satisfaction items, which used a 7-point Likert scale, and the Positive/Negative Affect items, which used a 5-point Likert scale. In total, the SWB instrument contained 17 items.

Meanwhile, the learning motivation instrument consisted of 32 items, all measured using a 5-point Likert scale to capture variations in students' motivational levels. The questionnaire contains a number of items for each variable; for example, questions on Subjective Well-Being evaluate life satisfaction for each student, and questions on Learning Motivation assess each student's desire to study. As for Mathematics Learning Outcome, the data is collected from each student's report card scores.

Prior to data analysis, both the SWB and learning motivation questionnaires were tested for validity and reliability using SPSS. Instrument reliability was examined using Cronbach's Alpha, where coefficient values above 0.60 indicate acceptable internal consistency.

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The data analysis used in this study is truncated spline nonparametric regression to assess the influence of each predictor variable on the response variable. This method was selected because truncated spline regression can model nonlinear relationships using piecewise polynomial functions that connect at selected knot points, allowing the model to adjust flexibly across different intervals without requiring strict assumptions of normality or homoscedasticity.

The truncated spline nonparametric regression model used in this study follows the general form:

$$y_i = \sum_{j=0}^{p} \beta_j x_i^j + \sum_{k=1}^{r} \beta_{p+r}(x_i - K_r)_+^p + \varepsilon_i, i = 1,2,\dots,n$$

where

$$(x_i - K_r)_+^p = \begin{cases} (x_i - K_r)^p, x_i \geq K_r \\ 0 \qquad\quad , x_i < K_r \end{cases}$$

represents the truncated polynomial basis at knot K_r (Wongkar & Ruliana, 2023).

The optimal knot point was selected using the Generalized Cross Validation (GCV) method. GCV aims to determine the knot position that produces the smallest prediction error, thereby preventing both overfitting and underfitting. The knot point that yields the minimum GCV value is regarded as the optimal knot and is subsequently used in the truncated spline regression model. The GCV criterion is defined as:

$$GCV(K) = \frac{MSE(K)}{[n^{-1}trace(\mathbf{I} - \mathbf{A})]^2}$$

This study design includes Subjective Well-Being and Learning Motivation as the predictor variables also Mathematics Learning Outcome as the response variable. The data analysis is done using two software: SPSS and RStudio.

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3. Findings and Discussion

3.1. Descriptive Statistics

According to Martias (2021), descriptive statistics is a type of statistics that involves gathering, organizing, and treating the data to be presented and provide a clear picture of a particular condition or event where the data is taken. In other words, the task of descriptive statistics is to represent data in a way that allows certain understandings or interpretations to be drawn based on the representation presented. The result of the descriptive statistics for each variable based on the output from SPSS are as follows:

Table 1 Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Subjective Well-Being	110	35	85	63.62	11.013	121.284
Learning Motivation	110	64	126	96.42	12.515	156.631
Mathematics Learning Outcome	110	73	92	81.29	3.740	13.988
Valid N (listwise)	110					

Based on table 1, the descriptive statistics indicate that the average Subjective Well-Being (SWB) score falls within the moderately high range, suggesting that most students report relatively positive emotional experiences and satisfactory life evaluations. Learning motivation also shows a high mean score, reflecting students' strong desire, persistence, and goal orientation toward learning mathematics. In contrast, the mean mathematics achievement score is in the moderate range, indicating considerable variation in students' performance.

The spread of values across all three variables shows patterns that are not strictly linear, as reflected by the range and distribution of the scores. This preliminary indication supports the need for a flexible modeling approach. Therefore, the subsequent use of truncated spline nonparametric regression is appropriate, as it can capture potential nonlinear relationships between the predictor variables and mathematics learning outcomes.

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3.2. Validity and Reliability Test

3.2.1. Validity Test

The validity test in this study was carried out using construct validity, specifically through item total correlation. Each item in the Subjective Well-Being (SWB) and learning motivation instruments was correlated with the total score of its respective variable to determine whether the item measured the same construct. An item is considered valid if the calculated correlation coefficient (r-count) is greater than the critical r-table value at the 5% significance level. This empirical approach is widely used in educational and psychological measurement to ensure that each item functions appropriately within a Likert-type instrument (Sugiono, 2020). Items that met the validity criteria were retained, while items that did not meet the threshold were removed from the final instrument.

Table 2 Validity Test Result for Subjective Well-Being

Item Number	Pearson Correlation	r-table	Note	Item Number	Pearson Correlation	r-table	Note
Item 1	0.584		Valid	Item 10	0.638		Valid
Item 2	0.705		Valid	Item 11	0.651		Valid
Item 3	0.757		Valid	Item 12	0.630		Valid
Item 4	0.516		Valid	Item 13	0.467		Valid
Item 5	0.476	0.1857	Valid	Item 14	0.482	0.1857	Valid
Item 6	0.551		Valid	Item 15	0.537		Valid
Item 7	0.537		Valid	Item 16	0.362		Valid
Item 8	0.623		Valid	Item 17	0.565		Valid
Item 9	0.664		Valid				

Table 3 Validity Test Result for Learning Motivation

Item Number	Pearson Correlation	r-table	Note	Item Number	Pearson Correlation	r-table	Note
Item 1	0.404	0.1857	Valid	Item 17	0.663	0.1857	Valid

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Item 2	0.277		Valid	Item 18	0.615		Valid
Item 3	0.539		Valid	Item 19	0.449		Valid
Item 4	0.561		Valid	Item 20	0.451		Valid
Item 5	0.669		Valid	Item 21	0.544		Valid
Item 6	0.386		Valid	Item 22	0.640		Valid
Item 7	0.391		Valid	Item 23	0.391		Valid
Item 8	0.713		Valid	Item 24	0.534		Valid
Item 9	0.622		Valid	Item 25	0.566		Valid
Item 10	0.608		Valid	Item 26	0.410		Valid
Item 11	0.507		Valid	Item 27	0.620		Valid
Item 12	0.653	0.1857	Valid	Item 28	0.728	0.1857	Valid
Item 13	0.396		Valid	Item 29	0.278		Valid
Item 14	0.224		Valid	Item 30	0.400		Valid
Item 15	0.498		Valid	Item 31	0.594		Valid
Item 16	0.732		Valid	Item 32	0.668		Valid

Based on tabel 2 and 3, The validity test was conducted using item total correlation by comparing the correlation coefficient of each item with the r-table value at a 5% significance level. The results show that all items in both the Subjective Well-Being (SWB) instrument and the learning motivation instrument exceeded the required validity threshold. Therefore, every item in both instruments meets the validity criteria and can be used for further analysis.

3.2.2. Reliability Test

Reliability was assessed using Cronbach's Alpha, computed through SPSS. Cronbach's Alpha evaluates internal consistency by measuring the extent to which items within a variable are interrelated. A coefficient value exceeding 0.60 is generally considered acceptable for research in social and educational contexts (Sugiono, 2020). The reliability results in this study showed that both the SWB and learning motivation instruments obtained Alpha values above

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this threshold, indicating that the instruments have sufficient internal consistency and are suitable for further statistical analysis.

Table 4 Reliability Test Results for Subjective Well-Being and Learning Motivation

Variable	Reliability Test Result	Note
Subjective Well-Being	**Reliability Statistics** Cronbach's Alpha: .863 N of Items: 17	Reliable
Learning Motivation	**Reliability Statistics** Cronbach's Alpha: .911 N of Items: 32	Reliable

Based on tabel 4, The results show that both the Subjective Well-Being (SWB) instrument and the learning motivation instrument obtained Cronbach's Alpha values above the commonly accepted reliability threshold of 0.60. Therefore, each instrument demonstrates adequate internal consistency, and both can be considered reliable for use in further analysis.

3.3. Scatterplot

Scatterplots are estimated to represent approximately 70–80% of all data visualizations in scientific publications. These graphs are simple because they represent bivariate data and are commonly interpreted in a uniform manner, making them ideal for any empirical study of visualization design and perceptions. Data visualization developers have an imperative to present graphs that are comprehensible to students with little statistical knowledge or graph-reading skills. For this reason, this study used non-expert participants with various levels of statistical comprehension and graphic literacy (Strain et al., 2023).

The images below are scatterplots of each predictor variable and response variable.

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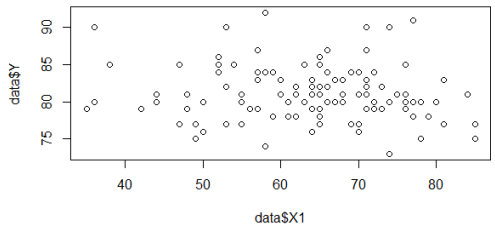

Figure 2 Scatterplot between Subjective Well-Being (X_1) and Mathematics Learning Outcome (Y)

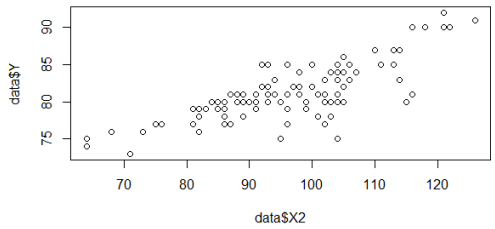

Figure 3 Scatterplot between Learning Motivation (X_2) and Mathematics Learning Outcome (Y)

Based on Figure 2 and 3 shows that scatterplot generated by Mathematics Learning Outcome with each predictor variable that allegedly effecting it disperse without following a particular pattern. Thus, truncated spline nonparametric regression can be used to identify the pattern that happened between the response variable and predictor variables.

3.3. Independent Assumption Test

In an ideal case of a regression model, an error in one observation should not affect other observations that have been determined at a specific time interval. If the error from one observation appears to affect other observations, it is called autocorrelation. If a regression model violates the classical assumption by having autocorrelation, the coefficient will be inefficient and inconsistent, and the possibility of error will be high. Therefore, an autocorrelation test is required, which is done by first calculating the residual data using the Durbin-Watson (D-W) calculation (Refiyana & Vefiadytria, 2024). Below is the result of the independent assumption test.

Table 5 Independent Assumption Result

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$d_{statistics}$	$d_{L;0,05}$	$d_{U;0,05}$	$4 - d_{L;0,05}$	$4 - d_{U;0,05}$
1,909	1,6523	1,7262	2,3477	2,2738

Based on table 5, we get that $d_U < d_{statistics} < 4 - d_U$ so it can be concluded that the residual fulfilled the independent assumption.

3.4. Truncated Spline Nonparametric Regression Modeling

3.4.1. Optimal Knot Point Selection

A knot point is a joint convergence point that happens when there's a change in behavior of a function at different intervals. The selection of knot points in nonparametric regression is important because it helps determine the best model based on certain values. In some studies, on nonparametric regression, the method often used in selecting the optimal knot point is Generalized Cross Validation (GCV) (Husain et al., 2024). The results of the 3 smallest GCV values are as follows

Table 6 Three Smallest GCV Values

GCV	R-Square	MSE	Knot
45,91786	65,18733	41,83838	43rd
45,95990	65,15546	41,87669	42nd
46,36715	64,84670	42,24776	41st

Based on table 6, the smallest GCV value obtained is 45,91786 so that the optimal knot point is in the 43rd knot.

3.4.2. Coefficient of Determination

From a perspective of mathematical derivatives, the changes in the response variable Y can be described in two parts: one caused by changes in the predictor variables that are accounted for, and the other caused by changes in the predictor variables that are not accounted for. The explained sum of squares (ESS) and the residual sum of squares (RSS) are used to represent the effects of the first and second parts, respectively, equal to ESS plus RSS. In

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regression, the common statistic used to calculate the regression effect is the coefficient of determination (Xu et al., 2022).

Based on Table 6, the optimal knot point was selected according to the smallest GCV value, which is 45.91786 at the 43rd knot. The corresponding coefficient of determination (R^2) is 65.18733%, indicating that the truncated spline nonparametric regression model with the 43rd knot is able to explain approximately 65% of the variation in mathematics learning outcomes based on the variables Subjective Well-Being (SWB) and learning motivation.

An R^2 value of 65.18733% suggests that the model has strong explanatory power, meaning that SWB and learning motivation contribute substantially to variations in students' mathematics performance. Meanwhile, the remaining approximately 35% of the variation lies outside the scope of the model and is not addressed in this study.

3.4.3. Truncated Spline Nonparametric Regression Equation

After analyzing the data, the following values were obtained for each parameter.

Table 7 Each Parameter Values

Parameter	Value
β_0	226,22
β_1	1,11
β_2	3,32
β_3	10,14
β_4	−7,04

Based on table 7, therefore the truncated spline nonparametric regression equation as follows.

$$\hat{y} = 226{,}22 + 1{,}11X_1 + (X_1 + 3{,}32)_+ + 10{,}14X_2 + (X_2 - 7{,}04)_+$$

3.5. Model Parameter Testing

3.5.1. Simultaneous Testing

Simultaneous testing is conducted using the F-statistic test. To examine the simultaneous effect of predictor variables on the response variable, the F-test is applied to the

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correlation parameters (Riza & Kusumo, 2023) The result of simultaneous model parameter testing as follows.

Table 8 Simultaneous Testing Result

Source	df	SS	MS	F-count	p-value(F)
Regression	4	1384.138	346.0345	270.8149	2.336435×10^{-54}
Error	105	140.5528	1.277753		
Total	109	1524.691			

Based on table 8, it was found that the p-value < 0,05, so we can say that all parameters simultaneously have a significant effect on the model. This result indicates that the truncated spline regression model, as a whole, is statistically meaningful in explaining the variation in mathematics learning outcomes. The large F-statistic value also reinforces that the combined contribution of Subjective Well-Being (SWB), learning motivation, and the spline components cannot be attributed to random chance. Therefore, the model proves to be effective when all parameters are considered together.

3.5.2. Partial Testing

The t-test is used to test the partial regression coefficient of the predictor variable. The t-test in this study determines the t-statistic table value specified at a significance level of 5% (Riza & Kusumo, 2023). The following is the results of the partial testing.

Table 9 Partial Testing Result

Variable	Parameter	t-count	p-value	Note
Subjective Well-Being	β_0	53.850071	$2,659380 \times 10^{-78}$	Significant
	β_1	-6.199569	$1,132160 \times 10^{-8}$	Significant
	β_2	21.814872	$8,516803 \times 10^{-41}$	Significant

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Learning Motivation	β_3	-8.787399	$3{,}182288 \times 10^{-14}$	Significant
	β_4	5.424707	$3{,}745806 \times 10^{-7}$	Significant

Based on table 9, we obtained that every parameter achieves p-value < 0,05 therefore every parameter ($\beta_0, \beta_1, \beta_2, \beta_3$, dan β_4) partially have a significant effect on the model. This result specifically indicates that Subjective Well-Being (SWB) has a significant effect on mathematics learning outcomes, as shown by the highly significant p-value of the coefficients associated with the SWB variable. Likewise, learning motivation also demonstrates a significant partial effect on mathematics learning outcomes, supported by its corresponding coefficients that are statistically significant.

4. Conclusion

This study examined the influence of Subjective Well-Being (SWB) and learning motivation on mathematics learning outcomes in 10th grade students at SMA Negeri 11 Samarinda using truncated spline nonparametric regression. The findings confirm that both SWB and learning motivation have a significant effect on students' mathematics learning outcomes, both partially and simultaneously. These results highlight the broader importance of non-cognitive factors in Indonesian mathematics education and emphasize the need for learning environments that support emotional stability and sustained motivation. Practical implications include the potential for schools and teachers to implement well-being-oriented counseling programs, motivational feedback strategies, and classroom practices that foster engagement and positive learning experiences.

Although the model explains a substantial portion of the variance in mathematics learning outcomes, some variation remains unaccounted for, indicating opportunities for further research. Future studies may incorporate additional psychological constructs, broaden the sample to different educational settings, or employ longitudinal designs to deepen the

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understanding of how SWB and learning motivation influence academic performance over time. Overall, this study provides new evidence by examining SWB and learning motivation together within a single model, offering clearer insight into their combined relevance and their significant contribution to mathematics learning outcomes of high school students in Indonesia.

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