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Multiple Linear Modelling in Revealing the Relationship between Learning Styles and Mathematics Performance

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Abstract

Learning style refers to individuals concentrating on processing, internalising, and retaining new and challenging academic information. Mathematics achievement is a level or nature of proven learning in a specific mathematical topic. It is a construct that shows how well someone has mastered mathematical ideas and abilities. This study intends to determine significant factors that contribute to mathematics achievement and learning styles in mathematics. The factors included were parental education and household income. The secondary objective of the research is to determine the relationship between learning style and mathematics achievement. Student's mathematics achievement was measured using their final academic session examination results. This study involved 246 form four students from Kinabatangan secondary school and was stratified into three levels of mathematics achievement: good, moderate and poor. Pearson Chi-square analysis confirmed a significant association between learning styles and mathematics achievement, showing that reflector learners tend to perform better in mathematics. In contrast, activist learners tend to perform lower in mathematics. Multiple regression analysis indicated that the reflector learning style and parents' educational background significantly contribute to mathematics achievement. These findings provide valuable insights for educators and curriculum designers, highlighting the importance of customised instructional strategies to improve student learning outcomes in mathematics.

Keywords: Mathematics Achievement, Learning Style, Multiple Regression, Pearson Chi-Square, Demographic Factor

Introduction

Mathematical achievement plays a key role in shaping students' career paths and contributes to the economic growth of a country (Maamin *et al*., 2021). Despite its significance, worldwide examinations such as TIMSS and PISA have found a decline in student mathematics

proficiency (Wiberg, 2019; Kong & Matore, 2021). Maamin *et al*. (2021) state various factors relating to students, families, schools, teachers, and policymakers influence mathematical achievement in ASEAN countries. Student-related factors comprise 45% of the studies on mathematics performance in these regions, with learning styles being identified as a significant predictor of mathematics achievement (Mundia and Metussin, 2019; Yusof *et al*., 2020). Anjani and Ulfah (2022) and Adu and Duku (2021) identified a significant relationship between learning styles and mathematics performance. In contrast, Ocampo *et al*. (2023) found no direct relationship between learning styles and mathematical achievement. However, Ocampo *et al*. (2023) noted that the impact of learning styles might be moderated by factors such as teacher quality, student motivation, and demographic characteristics.

Multiple regression is a statistical method used to predict the value of a dependent variable based on two or more independent variables. For instance, Fitrianti and Riyana (2020) used multiple regression to examine how students' learning habits and gender predict their mathematics achievement. Similarly, Alibraheim (2019) explored the relationship between students' demographic characteristics and their attitudes toward mathematics achievement. Hussin and Matore (2023) also employed multiple regression analysis to assess the impact of learning styles on students' academic procrastination in mathematics.

In educational research, multiple regression modelling is a highly effective statistical tool for understanding the relationship between various predictors and a dependent variable, such as students' mathematics achievement (Hamidy and Lam, 2022). This method enables researchers to assess how multiple independent variables collectively influence mathematics performance, including students' learning styles and demographic factors. By analysing these predictors concurrently, multiple regression modelling offers a nuanced and comprehensive view of how these factors interact. It reveals their combined effects on students' mathematical outcomes and provides valuable insights into the mechanisms that drive academic success (Alshanqiti and Namoun, 2020).

Mursito and Dermawan (2023) conducted a regression analysis to assess the impact of student learning styles on mathematics outcomes. The analysis revealed that the overall regression model was significant. The student learning style variable showed a negative regression coefficient of -0.126, with a t-value of 2.230 and a p-value of 0.03, suggesting that this variable was a significant predictor in the model. The model's R-squared value was 0.094, meaning that 9.4% of the variation in the mathematics outcomes could be explained by the student learning style variable. This indicates that, although student learning style is a significant predictor, other important variables also contribute to mathematics outcomes, which were not explored in this model.

Mathematics achievement is influenced not only by learning styles but also by factors like parental education level and household income. Maternal education, in particular, has been positively linked to mathematics achievement (Magsino, 2021; Isha and Hashim, 2022). This finding is in line with Gobena (2018), who emphasised the role of parental education levels in influencing students' academic success. Similarly, Wang *et al*. (2023) identified a strong connection between mathematics achievement and parental educational background.

Furthermore, Vadivel *et al*. (2023) highlight the impact of economic factors on academic performance. Li and Qiu (2018) further explain that families with different socioeconomic statuses often create varied learning environments that significantly influence student success.

Methodology

The methodology section outlines the approach used to conduct the research, detailing how data were collected, analysed, and interpreted. It explains the steps taken to answer the research questions, including the tools, techniques, and procedures used.

Data Collection

The study's population consisted of secondary school students from Kinabatangan, where the schools are located nearly 50 kilometres apart. The sample size was determined using an alternative formula proposed by Krejcie and Morgan (1970). This calculation was based on a 95% confidence level. With a total population of 677 students, a sample size of 246 was selected using a purposive and stratified sampling method.

Instrument

This study surveyed secondary school students in Kinabatangan, in which a questionnaire was used to collect primary data directly from the respondents. The second key data source was the students' mathematics performance in the Final Academic Session Examination (FASE). The structure and design of the questionnaire were based on previous studies. The questionnaire was structured into two parts: Section A covered student demographics, and Section B focused on learning styles.

The initial section of the survey inquired about the demographic characteristics of the students. The assessment encompassed the following variables: gender, parents' educational background, parental income, and mathematics score. Respondents were required to select appropriate responses. However, the mathematics score of the students was obtained directly from the school authority to ensure the respondents responded to the actual mathematics scores. The second part of the questionnaire examines the students' learning styles. This study used an adapted version of Honey and Mumford's Learning Styles Inventory (1992) to measure the learning styles variable. Eighty items of the instrument were divided into four subsets of 20 items, which gauge learning styles: activist, reflector, pragmatist, and theorist. The randomised items did not display the learning style categories to allow the respondents to react freely based on their actual behaviour (Khan, 2021). The original Learning Style Questionnaire used a dichotomous scale. Chang and Tzang (2021) transformed the yes-or-no model into a 4-point Likert scale. Berisha *et al*. (2024) used the 5-point Likert scale to capture a broader spectrum of opinions and behaviours from respondents' perspectives. In this study, each item was further reformatted into a 5-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (completely agree), based on how students perceived themselves in various scenarios.

The Learning Styles Questionnaire provides two types of scores for each learning style: raw and percentile. The raw score represents the total number of statements a student agreed with for a particular learning style. The Learning Styles Questionnaire compares students' raw scores against those of a norm group drawn from the general population

(Sample, 1999; Mak *et al*., 2007). In this study, the raw scores were compared with general norms proposed by Honey and Mumford (1992). This allows the students' scores to reflect their preference for one learning style over others.

Table 1 below outlines the method for determining the dominant learning style. Each learning style's raw score was compared against the general norms. In this case, the activist has a dominant learning style compared to others.

Table 1
The Dominant Learning Style

Learning Style	Raw Score	Very Low	Low	Mild	High	Very High
Activist	19					
Reflector	6					
Theorist	9					
Pragmatist	16					

Source : (Sample, 1999; Mak *et al*., 2007)

TRAPD method is used to perform the instrument translation and adaptation. TRAPD approach is recognised in intercultural social research, which can ensure the accuracy, cultural relevance, and reliability of translated survey instruments across various disciplines and languages (Krell *et al*., 2020; Walde and Völlm, 2023).

The internal consistency based on Cronbach's alpha was obtained by employing scale analysis to ascertain the measuring scale's reliability in this study. Table 2 displays Cronbach's alpha coefficients for each learning style, ranging from 0.652 to 0.755, with an overall coefficient of 0.862. These values indicate that the LSQ has a satisfactory to a high level of internal consistency for measuring different learning styles (Chua Yan Piaw, 2022; Raharjanti *et al*., 2022; Ursachi *et al*., 2015)

Table 2
Internal Consistency of LSQ

Learning Style	**Cronbach's Alpha**	**Internal Consistency**
Activist	0.652	Satisfactory
Reflector	0.755	Satisfactory
Theorist	0.678	Satisfactory
Pragmatist	0.690	Satisfactory
Overall	0.862	High and Satisfactory

Source : (Chua Yan Piaw, 2022; Raharjanti *et al*., 2022; Ursachi *et al*., 2015)

Statistical Analysis

The data were carefully analysed using SPSS version 29, a powerful tool for extracting meaningful insights. To start, descriptive analysis was applied, offering a clear picture of the respondents' demographic background and shedding light on the key variables at play. This helped to set the stage for deeper exploration. Next, stepwise multiple linear regression was

conducted to identify the significant factors affecting students' mathematics achievement. By systematically testing different variables, the most impactful elements that shape students' achievement in mathematics were discovered. Finally, Pearson Chi-square analysis was used to explore the relationship between learning styles and mathematics achievement. This statistical test helped to reveal whether different learning styles were linked to students' achievement in mathematics, providing valuable insights into how teaching methods could be tailored to improve outcomes. In this way, the data analysis journey unfolded, with each step providing a clearer understanding of the factors that contribute to students' mathematical achievement.

Stepwise Multiple Linear Regression

Multiple regression was a statistical method used to analyse the relationship between mathematics achievement and several independent variables. Multiple regression was utilised to create an equation that predicts the criterion performance from the set of predictors. The multiple regression model is expressed as

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_k X_{ki} \dots \epsilon_i \qquad i = 1, \dots\dots, n \qquad (1)$$

Where;
$Y_i =$ mathematics achievement
$x_i, x = 1, 2, \dots, m =$ demographic factor, learning style
$\beta_0 =$ intercept
$\beta_i =$ regression coefficient for each independent variable
$\epsilon_i =$ random error

The Assumptions for Multiple Regression

Multiple regression analysis relies on several key assumptions to ensure the results are valid and reliable. These assumptions help to confirm that the relationships between variables are accurately represented and that the statistical tests provide meaningful insights. Understanding and testing these assumptions is essential before drawing conclusions from the regression model.

Autocorrelation

The Durbin-Watson was used to indicate the autocorrelation in the data. The Durbin-Watson statistic spans a range from 0 to 4. A value near 2 indicates the absence of autocorrelation, while values closer to 0 point to positive autocorrelation, and values approaching 4 imply negative autocorrelation (Aisami *et al*., 2021; Turner *et al*., 2021). The Durbin-Watson statistic is calculated as the ratio of the sum of squared differences between successive residuals to the sum of the squared residuals:

$$DW = \frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2} \qquad (2)$$

Outliers can significantly affect a regression model by distorting its results and breaking key assumptions. Detecting and managing outliers is crucial to keep the model accurate and reliable. Methods like Cook's Distance and leverage values were employed to

identify the data points that excessively influence the model. Cook's Distance was calculated for each data point using the following formula:

$$D_i = \frac{\sum_{j=1}^{n}(\hat{y}_i - \hat{y}_{ji})^2}{p \times MSE} \quad (3)$$

Where:
MSE = mean squared error of the model
p = number of predictors in the model

Outlier Test

Cook's Distance was a method employed to determine the outlier. It is considered high above 0.5 and extreme if greater than 1 (Chen *et al*., 2020). Multicollinearity was evaluated using the variance inflation factor (VIF) and tolerance values. The formulas for VIF and tolerance were used as follows:

$$VIF = \frac{1}{1 - R_i^2} \quad (4)$$

$$Tolerance = \frac{1}{VIF} \quad (5)$$

A tolerance value below 0.1 to 0.2 indicates the presence of multicollinearity (Chen *et al*., 2020; Kim, 2019). To clarify when multicollinearity may be problematic, Table 3 provides guidelines for interpreting variance inflation factor (VIF) values, offering a more precise framework for identifying and addressing multicollinearity concerns in regression analysis.

Table 3
VIF Value

VIF	Interpretation
1	Not Correlated
$1 < VIF \leq 5$	Moderately correlated
> 5	Highly Correlated

Source **:** (Kim, 2019; Daoud 2017; Kyriazos and Poga, 2023)

Pearson Chi-square

To determine the relationship between learning styles and mathematics achievement, a Pearson Chi-square test was performed using SPSS 29.0. The learning styles were categorised as activist, pragmatist, reflector, and theorist, while mathematical achievement was classified as good, moderate, and poor.
The following is the Chi-square statistic formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (6)$$

Where;
χ^2 = chi-squared
O_i = observed valued
E_i = expected valued

Results and Discussions

Table 4 summarises the demographic characteristics of a group of students, detailing their gender, mathematics achievement, parents' educational backgrounds, and parents' income levels. The group comprises 98 male students (39.8%) and 148 female students (60.2%). In terms of mathematics achievement, 82 students (33..3%) performed well, 82 students (33.3%) had moderate performance, and another 82 students (33.3%) performed poorly.

Most of the fathers had a secondary level of education or below, with only 15.5% having completed tertiary education. In contrast, a lower percentage of mothers had secondary education or below, with only 11.8% having attained tertiary qualifications. This shows that, while both parents had relatively low educational attainment, fathers were slightly more likely to have completed higher education compared to mothers in this sample.

Table 4
Demographic Characteristics $(n = 246)$

Demographic Characteristic	Frequency (*f*)	Percentage (%)
Gender		
Male	98	39.8
Female	148	60.2
Mathematic Achievement		
Good	82	33.3
Moderate	82	33.3
Poor	82	33.3
Father's Educational Background		
Secondary	89	36.2
STPM/Diploma	24	9.8
Degree	12	4.9
Master	2	0.8
None	119	48.4
Mother's Educational Background		
Secondary	87	35.4
STPM/Diploma	19	7.7
Degree	9	3.7
Master	1	0.4
None	130	52.8
Father's Income		
None to RM2 559	29	11.8
RM2 560 – RM5 249	179	72.8
RM5 250 – RM11 819	34	13.8
More than RM11 819	4	1.6
Mother's Income		
None to RM2 559	167	67.9
RM2 560 – RM5 249	71	28.9
RM5 250 – RM11 819	6	2.4
More than RM11 819	2	0.8

Multiple Linear Regression

In the stepwise procedure, all learning style variables and one of the demographic variables were included. In this model, the father with no formal education (X_{3a}), together with the activist (X_{8a}), pragmatist (X_{8b}), reflector (X_{8c}) and theorist (X_{8d}) were included in this model. The results are shown in Table 5.

Table 5
Multiple Regression Model

Model 1							
Coefficient						Value	
R						0.282	
R^2						0.079	
Adjusted R^2						0.072	
Standard Error of the Estimate						13.986	
Variance Analysis							
Sum of Square			df	Mean Square		F	Sig.
Regression	4094.411		2	2047.206		10.466	<0.001
Residual	47531.719		243	195.604			
Variable	Regression Coefficient					Collinearity	
	β	Error E.	Beta	t	Sig	Tolerance	VIF
Constant	31.628	3.984		7.939	<0.001		
X_{8c}	1.034	0.267	0.239	3.871	<0.001	0.991	1.009
X_{3a}	-3.694	1.792	-0.127	-2.061	0.040	0.991	1.009

The results of the stepwise method, as shown in Table 5, revealed a weak to moderate positive relationship between the reflector (X_{8c}), the father with no formal education (X_{3a}) and mathematics achievement. This model was significant (R^2= 0.079, p<0.001), indicating that the model explains 7.9% of the variation in mathematics achievement. The findings revealed that the reflector learning style (β=1.034, t=3.871, p<0.001) and having a father with no formal education (β=−3.694, t=−2.061, p=0.040) were essential predictors of mathematics achievement. The ANOVA results further confirm the model's significance, with an F=10.466, df=2 and a p=<0.001.

Multicollinearity and Normality Test of the Models

The model's assumptions regarding multicollinearity were assessed using VIF and tolerance values. The Durbin-Watson analysis indicated that the residuals have no significant autocorrelation, as the Durbin-Watson statistic was close to 2 (2.068), suggesting that the residuals were independent. In this analysis, the VIF value was 1.009, and the tolerance value was 0.991, well within acceptable limits.

Next is the detection of outliers. In this analysis, the maximum Cook's distance was 0.107, well below the threshold of 1. This indicated that no single observation has an undue

influence on the regression model. Since the maximum Mahalanobis distance (12.089) was below this critical value, it suggested no extreme multivariate outliers in the data. The leverage values range from 0.004 to 0.049. Generally, leverage values greater than the threshold of approximately 0.024. Since the maximum leverage value (0.049) was above this threshold, some observations may have a higher influence, but they were only considered extreme, surpassing typical critical thresholds (2).

Pearson Chi-Square Analysis

This subsection explored the relationship between learning styles and mathematics achievement through crosstabulation and Pearson Chi-square analysis. Table 6 presents a comprehensive distribution of students' mathematics achievement levels according to their learning styles. The mathematics achievements were cross tabulated with the four distinct learning styles.

Table 6

Mathematics Achievement and Learning Style Crosstabulation

Mathematic Achievement	Learning Style				Total
	Activist	Pragmatist	Reflector	Theorist	
Good	14	5	52	11	82
Moderate	20	0	51	11	82
Low	38	1	34	9	82
Total	72	6	137	31	246

The Pearson Chi-square analysis ($\chi^2 = 24.740$, df =6, p = <0.001) showed a significant p-value. This result indicated a statistically significant association between mathematical achievement and learning styles.

Discussion

The multiple regression model developed in this study accounted for 7.9% of the variation in mathematics achievement (F=10.466, df=2, p<0.05). The analysis identified two significant predictors: the reflector learning style and having a father with no formal education.

These findings suggest that students with a reflector learning style tend to achieve higher in mathematics (β=1.034, p<0.05), while those whose fathers have no formal education are more likely to have lower mathematics achievement (β=−3.694, p<0.05). The model highlights the critical roles of learning styles and parental education levels in influencing students' mathematics outcomes. This result is consistent with previous research, demonstrating a significant relationship between learning styles and mathematics performance (Villajuan, 2019; Novita, 2022).

The findings of this study align with those of Alibraheim (2019), who identified a significant relationship between students' demographic characteristics and their attitudes toward success in mathematics. Similarly, Fitrianti and Riyana (2020) found that learning habits significantly influence mathematics learning achievement, while gender did not significantly affect student performance in this subject. Consistent with these results, this study also found that gender did not substantially impact mathematics achievement.

Furthermore, the Pearson Chi-square test showed a significant association between learning style and mathematics achievement. The cross-tabulation analysis provided additional insights, revealing that students with a reflector learning style tend to achieve good to moderate mathematics results. In contrast, those with an activist learning style are likelier to have lower mathematics achievement. These findings emphasise the significant influence of learning styles on student's performance in mathematics (Mangwende, 2024)

This finding is consistent with previous research by Tahir *et al*. (2019), which showed that the activist learning style was associated with lower rates of academic success and higher rates of poor academic performance. This pattern is also observed in health education, where students with an activist profile presented statistically lower performance than their non-activist peers. In contrast, students with theoretical and reflective learning styles performed better (Oliveira *et al*., 2023).

Contrarily, a study conducted by Tahir *et al*. (2019) using the Honey and Mumford LSQ indicated that the reflector style is the least prevalent among accounting course students. Like Khan's study (2021), high academic achievers in integrated skills subjects were identified as pragmatist and activist learners, while lower achievers tended to be reflective and theorist learners. This suggests that the effectiveness of learning styles might vary across different subjects.

This study made an important contribution by discovering a strong correlation between learning styles and mathematical achievement, emphasising the need to recognise and adjust to each student’s unique learning preferences. It also highlighted how a student’s success in mathematics could be influenced by the educational background of their parents. The findings suggested that students with a reflector learning style were more likely to excel, while those with an activist style may have faced greater challenges in their mathematics progress.

By incorporating these insights into educational practices, teachers can develop more tailored and effective teaching methods that cater to diverse student needs, thus benefiting both students and the educational system as a whole. Moreover, this study opens the door for future research that can further investigate not only the direct effects of learning styles and parental influence but also the intricate relationship between student motivation, learning style, and academic achievement. This will allow educators and policymakers to create more comprehensive strategies to foster student success.

Conclusion

The current study's findings revealed that the reflector learning style and having a father with no formal education significantly contributed to students' mathematics achievement. Based on the Pearson Chi-square analysis indicated a relationship between learning style and mathematics achievement, showing that the reflector learning style is more common among good and moderate achievers. In contrast, the activist learning style is prevalent among poor achievers. To address these factors and improve student performance, it is recommended that parents, teachers, and policymakers collaborate to develop targeted methods or programs. For future research, structural equation modelling is suggested to examine these variables' direct and indirect effects on mathematics achievement. Additionally, it would be

beneficial to incorporate other potential influencing factors, such as teaching methods, student motivation, educational support, and attendance, to understand better what impacts students' success in mathematics.

In summary, Table 4.24 highlights a significant correlation between students' mathematical achievement and their learning styles. Reflectors are the most common learning style among students with both good and moderate achievements, while activists are more common among poor achievers. The Pearson Chi-square test confirms the statistical significance of this association, meaning a relationship exists between learning style and mathematics achievement.

References

Adu, E. O., & Duku, N. (2021). *Learning Styles and Instructional Materials as Correlates of Grade 6 Learners` Mathematics Performance in Buffalo City, South Africa*. Research in Social Sciences and Technology. https://doi.org/10.46303/ressat.2021.41

Aisami, A., Abubakar, U., Manogaran, M., & Shukor, M. (2021). Test for the Presence of Autocorrelation in the Morgan-Mercer-Flodin (MMF) Model used for Modelling the Total Number of COVID-19 Cases for Brazil. Bulletin of Environmental Science and Sustainable Management (e-ISSN 2716-5353), 5(1), 32–36. https://doi.org/10.54987/bessm.v5i1.589

Alibraheim, E. A. (2019). Demographic factors affecting freshman engineering students' attitudes toward mathematics at a university in saudi arabia (Order No. 28216839). Available from Education Collection. (2468702145). Retrieved from https://www.proquest.com/dissertations-theses/demographic-factors-affecting-freshman/docview/2468702145/se-2

Alshanqiti, A., & Namoun, A. (2020). Predicting Student Performance and Its Influential Factors Using Hybrid Regression and Multi-Label Classification. *IEEE Access*, *8*, 203827–203844. https://doi.org/10.1109/access.2020.3036572

Anjani, F., & Ulfah, S. (2022). *Secondary students' mathematical reasoning in terms of learning styles on online learning*. Jurnal Elemen. https://doi.org/10.29408/jel.v8i2.5696

Berisha, V., Rexhepi, H., Rexhepi, M., & Klinaku, B. (2024). An investigation of the students' viewpoint on factors affecting achievement in mathematics. Pegem Egitim Ve Ogretim Dergisi = Pegem Journal of Education and Instruction, 14(2), 309-315. doi:https://doi.org/10.47750/pegegog.14.02.35

Chang, Y. C., & Tzang, R. F. (2021). Proposing and Validating the Diagnosis Scale for Internet Gaming Disorder in Taiwanese ADHD Adolescents: Likert Scale Method Based on the DSM-5. International Journal of Environmental Research and Public Health, 18(4), 1492. https://doi.org/10.3390/ijerph18041492

Chen, W., Feng, Y., Fang, J., Wu, J., Huang, X., Wang, X., Wu, J., & Zhang, M. (2020). Effect of trust in primary care physicians on patient satisfaction: a cross-sectional study among patients with hypertension in rural China. BMC Family Practice, 21(1). https://doi.org/10.1186/s12875-020-01268-w

Piaw, C. Y. (2022). Asas Statistik Penyelidikan (4th ed., Vol. 2). Mc Graw Hill.

Daoud, J. I. (2017). Multicollinearity and Regression Analysis. Journal of Physics Conference Series, 949, 012009. https://doi.org/10.1088/1742-6596/949/1/012009

Fitrianti, H., & Riyana, M. (2020). Analysis the effect of learning habists and gender the mathematics learning achievement using the multiple linear regression

approach. *Journal of Physics Conference Series*, *1569*(4), 042071. https://doi.org/10.1088/1742-6596/1569/4/042071

Gobena, G. A. (2018). Family Socio-Economic Status Effect on Students' Academic Achievement at College of Education and Behavioral Sciences, Haramaya University, Eastern Ethiopia. *Journal of Teacher Education and Educators*, *7*(3), 207–222. http://files.eric.ed.gov/fulltext/EJ1207284.pdf

Hamidy, A., & Lam, K. F. T. (2022). Determinant factors of mathematics achievement in online learning during the covid-19 pandemic. *Jurnal Riset Pendidikan Matematika*, *9*(1), 12–21. https://doi.org/10.21831/jrpm.v9i1.48860

Hussin, W. A. S. W., & Matore, M. E. E. M. (2023). The influence of learning styles on academic procrastination among students in mathematics. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1239933

Honey, P., & Mumford, A. (1992). The manual of learning styles. Berkshire: Peter Honey Publications.

Isha, D. S. N. S. B. A., & Hashim, S. R. B. M. (2022). Application of Multiple Linear Regression in Identifying Contributing Factors in Students' Academic Achievement. In *ICMSS 2022* (pp. 364–377). https://doi.org/10.2991/978-94-6463-014-5_32

Khan, M. R. (2021). Learning Styles and Academic Achievement among Form Three Living Integrated Skills Students. *ASM Science Journal*, *16*, 1–13. https://doi.org/10.32802/asmscj.2021.819

Kim, J. H. (2019). Multicollinearity and misleading statistical results. Korean Journal of Anesthesiology, 72(6), 558–569. https://doi.org/10.4097/kja.19087

Kong, S. F., & Matore, M. E. E. M. (2021). Can a Science, Technology, Engineering, and Mathematics (STEM) Approach Enhance Students' Mathematics Performance? *Sustainability*, *14*(1), 379. https://doi.org/10.3390/su14010379

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. Educational and Psychological Measurement, 30(3), 607–610. https://doi.org/10.1177/001316447003000308

Krell, M., Mathesius, S., Van Driel, J., Vergara, C., & Krüger, D. (2020). Assessing scientific reasoning competencies of pre-service science teachers: translating a German multiple-choice instrument into English and Spanish. *International Journal of Science Education*, *42*(17), 2819–2841. https://doi.org/10.1080/09500693.2020.1837989

Kyriazos, T., & Poga, M. (2023). Dealing with Multicollinearity in Factor Analysis: The Problem, Detections, and Solutions. Open Journal of Statistics, 13(03), 404–424. https://doi.org/10.4236/ojs.2023.133020

Li, Z., & Qiu, Z. (2018). How does family background affect children's educational achievement? Evidence from Contemporary China. *The Journal of Chinese Sociology*, *5*(1). https://doi.org/10.1186/s40711-018-0083-8

Maamin, M., Maat, S. M., & Iksan, Z. H. (2021, February 25). *Analysis of the factors that influence mathematics achievement in the ASEAN countries*. Cypriot Journal of Educational Sciences. https://doi.org/10.18844/cjes.v16i1.5535

Magsino, E. A. (2021). The Effect of Social Learning-Related Variables on Academic Achievement. International Journal of Educational Management and Development Studies, 2(1), 104–121. https://iiari.org/wp-content/uploads/ijemds.v2.2.151.pdf

Mak, W. M., Chang, J., Hsia, P., Chan, J., & Yu, B. (2007). The Use Of Learning Styles Questionnaire In Hong Kong. In Developments in Business Simulation and Experiential Learning (Vol. 34, pp. 138–140).

Mangwende, E. (2024). Learning Styles and Academic Achievement of Distance e-Learning University Mathematics Students: A Case of a University in Zimbabwe. *European Journal of Education and Pedagogy*, *5*(1), 61–65. https://doi.org/10.24018/ejedu.2024.5.1.324

Mundia, L., & Metussin, H. (2019). Exploring factors that improve mathematics achievement in Brunei. *Studies in Educational Evaluation*, *60*, 214–222. https://doi.org/10.1016/j.stueduc.2018.10.003

Mursito, M., & Dermawan, D. (2023). Pengaruh Gaya Belajar terhadap Prestasi Belajar Siswa pada Mata Pelajaran Matematika Kelas VIII SMP PB Sudirman Bekasi Tahun Pelajaran 2022-2023. FOCUS, 4(2), 125–128. https://doi.org/10.37010/fcs.v4i2.1286

Novita, N. (2022). The Relationship between Student Learning Styles and Mathematics Learning Outcomes in Set Materials in Class VII MTs Daarul Falah. *INTELEKTIUM*, *3*(2), 396–402. https://doi.org/10.37010/int.v3i2.1086

Ocampo, E. N., Mobo, F. D., & Cutillas, A. L. (2023). Exploring the Relationship Between Mathematics Performance and Learn-ing Style Among Grade 8 Students. International Journal of Multidisciplinary: Applied Business and Education Research, 4(4), 1165–1172. https://doi.org/10.11594/ijmaber.04.04.14

Oliveira, A., Spinola, V., Garrido, D., Teixeira, M. M., Salles, C., & Haddad, A. E. (2023b). Influence of learning styles on student performance in self-instructional courses. *PLoS ONE*, *18*(7), e0289036. https://doi.org/10.1371/journal.pone.0289036

Raharjanti, N. W., Wiguna, T., Purwadianto, A., Soemantri, D., Indriatmi, W., Poerwandari, E. K., Mahajudin, M. S., Nugrahadi, N. R., Roekman, A. E., Saroso, O. J. D. A., Ramadianto, A. S., & Levania, M. K. (2022). Translation, validity and reliability of decision style scale in forensic psychiatric setting in Indonesia. Heliyon, 8(7), e09810. https://doi.org/10.1016/j.heliyon.2022.e09810

Sample, J. (1999). Understanding Your Learning Styles (p. 1). https://www.psychpress.com.au/Psychometric/products/others/LSQ%20Report%20(Sample).pdf

Shih, J. H., & Fay, M. P. (2017). Pearson's chi-square test and rank correlation inferences for clustered data. *Biometrics*, *73*(3), 822–834. https://doi.org/10.1111/biom.12653

Turner, S. L., Forbes, A. B., Karahalios, A., Taljaard, M., & McKenzie, J. E. (2021). Evaluation of statistical methods used in the analysis of interrupted time series studies: a simulation study. BMC Medical Research Methodology, 21(1). https://doi.org/10.1186/s12874-021-01364-0

Tahir, W. M. M. W., Hussin, A. H., & Jabar, J. A. (2019). *Students' learning styles and their academic performance in Accounting Course / Wan Mardyatul Miza Wan Tahir. . . [et al.]*. https://ir.uitm.edu.my/id/eprint/31182/

Ursachi, G., Horodnic, I. A., & Zait, A. (2015). How Reliable are Measurement Scales? External Factors with Indirect Influence on Reliability Estimators. Procedia Economics and Finance, 20, 679–686. https://doi.org/10.1016/s2212-5671(15)00123-9

Vadivel, B., Alam, S., Nikpoo, I., & Ajanil, B. (2023). The Impact of Low Socioeconomic Background on a Child's Educational Achievements. *Education Research International*, *2023*, 1–11. https://doi.org/10.1155/2023/6565088

Villajuan, A. M. L. (2019). Relationship between Learning Styles & Academic Achievement in Mathematics of Grade 8 Students. *International Journal of English Literature and Social Sciences*, *4*(4), 1052–1055. https://doi.org/10.22161/ijels.4419

Wang, X. S., Perry, L. B., Malpique, A., & Ide, T. (2023). Factors predicting mathematics achievement in PISA: a systematic review. *Large-scale Assessments in Education*, *11*(1). https://doi.org/10.1186/s40536-023-00174-8.

Walde, P., & Völlm, B. A. (2023). The TRAPD approach as a method for questionnaire translation. *Frontiers in Psychiatry*, *14*. https://doi.org/10.3389/fpsyt.2023.1199989

Wiberg, M. (2019). The relationship between TIMSS mathematics achievements, grades, and national test scores. *Education Inquiry*, *10*(4), 328–343. https://doi.org/10.1080/20004508.2019.1579626

Yusof, N. S. H. C., Ismail, I. S., Razak, N. F. A., Ibrahim, F. I., Pu'ad, N. M., & Ramali, N. S. (2020). *Factors Influencing Mathematics Performance among Secondary School Students*. Malaysian Journal of Social Sciences and Humanities. https://doi.org/10.47405/mjssh.v5i11.533