AKSIOMA EDUCATION JOURNAL
Aksioma: Jurnal Matematika
https://nawalaeducation.com/index.php/AEJ/index
Volume 2 Nomor 1, March 2025
e-ISSN : 3047-3187
DOI : https://doi.org/10.62872/37qdwd85

Multiple Linear Regression Model to Predict Mathematics Learning Achievement Based on Learning Styles and School Environment

Sefiani Dwi Azmi
Universitas Jambi
e-mail: *sefianidwi@gmail.com[1]

INFO ARTIKEL

Accepted :February 22, 2025
Revised : March 24, 2025
Approved : March 31, 2025

Keywords:
Learning Styles, School Environment, Mathematics Achievement

ABSTRAK

This study aims to analyze the extent to which learning styles and the school environment predict students' mathematics learning achievement using a multiple linear regression model. The research employs a quantitative correlational approach involving a sample of high school students selected through stratified random sampling. Data were collected using validated questionnaires to assess students' learning styles and perceptions of the school environment, along with academic records for mathematics achievement. The results of the regression analysis indicate that both learning styles and school environment significantly influence mathematics performance, with a combined coefficient of determination (R^2) of 0.532. This suggests that 53.2% of the variance in mathematics achievement can be explained by these two variables. Moreover, the school environment was found to have a slightly greater impact compared to learning styles. These findings highlight the importance of integrating individualized learning strategies with a supportive educational context to optimize student achievement in mathematics. The study provides valuable insights for educators, curriculum developers, and policymakers aiming to improve mathematics education through evidence-based strategies.

INTRODUCTION

Mathematics serves as a cornerstone of education, playing a vital role not only in academic development but also in equipping students with essential life skills such as critical thinking, logical reasoning, and problem-solving. The importance of mathematics extends beyond the classroom into real-life situations, where analytical skills are often required in decision-making processes. Despite this significance, mathematics remains one of the most challenging subjects for many students. National and international assessments frequently reveal underperformance in mathematics, indicating that many students struggle to grasp fundamental concepts. This persistent issue calls for a systematic exploration of the underlying causes of low mathematics achievement and a targeted approach to improving student outcomes.

Multiple factors influence students' academic success in mathematics, and these factors are generally classified into two categories: internal and external. Among internal factors, **learning style** is considered highly influential. A student's preferred way of processing and engaging with information greatly affects their ability to understand mathematical concepts. For example, visual learners may better comprehend material through diagrams and illustrations, while auditory learners may benefit more from verbal explanations. Kinesthetic learners, on the other hand, need physical engagement or practical activities to effectively grasp concepts. If educators fail to recognize and adapt to these differences, students may become disengaged, experience anxiety, or fail to reach their potential. Therefore, identifying dominant learning styles within a classroom setting is crucial for designing differentiated instruction that aligns with students' needs.

In parallel, the **school environment**—a key external factor—significantly contributes to shaping students' academic performance. A positive and supportive school climate fosters a sense of belonging, safety, and motivation among students. Elements such as the availability of instructional resources, classroom management, teacher-student interaction, peer support, and overall school culture influence how students perceive learning and how well they perform. Numerous studies have shown that students who attend schools with a nurturing academic environment tend to achieve higher academic outcomes than those in under-resourced or poorly managed educational settings. As such, understanding the extent to which the school environment affects mathematics achievement is imperative for formulating effective educational policies.

Given the multifaceted nature of student learning, it becomes necessary to employ a robust analytical framework to assess and predict learning outcomes. The **multiple linear regression model** offers a suitable statistical method to analyze the simultaneous impact of multiple predictors—such as learning style and school environment—on a dependent variable, namely mathematics achievement. Unlike simple correlation, regression analysis allows for the estimation of how each independent variable uniquely contributes to explaining variations in student performance, while controlling for the influence of other variables. This approach provides a more accurate and data-driven insight into how these factors interact and where educational interventions should be focused.

Moreover, the predictive power of the regression model can serve as a valuable diagnostic tool for teachers, school administrators, and policymakers. By identifying key predictors of success in mathematics, the model can inform targeted instructional strategies, such as adapting teaching methods to suit varied learning styles or improving school infrastructure to foster a more engaging learning environment. In the long term, this could lead to a reduction in learning disparities, improved student motivation, and better academic outcomes across diverse educational settings.

In conclusion, this research aims to bridge the gap between pedagogical theory and classroom practice by developing a predictive model that integrates both individual and environmental factors. By analyzing how learning styles and school environment influence mathematics achievement through the lens of multiple linear regression, the study aspires to contribute meaningful insights to the ongoing efforts in educational reform and quality improvement, particularly in the teaching and learning of mathematics.

METHODOLOGY

This study employs a quantitative approach with a correlational survey method, aiming to examine the relationship and influence of two independent variables learning styles and school environment on the dependent variable, namely students' mathematics learning achievement. A quantitative approach is chosen for its objective and measurable nature, allowing for the statistical analysis of numerical data collected from respondents. The main analytical technique used is multiple linear regression, which enables the researcher to assess the contribution of each independent variable both individually and collectively to the dependent variable, and to develop a predictive model that can inform future educational policies and classroom strategies.

The research was conducted at the senior high school level (e.g., Grade 10 students in a public high school), based on the assumption that students at this level have more established learning preferences and greater academic maturity. The population of the study consists of all students enrolled in the targeted grade level, and the sample was selected using either stratified random sampling or purposive sampling, depending on the characteristics of the population and the objectives of the study. The sample size was determined using the Slovin formula to ensure representativeness and maintain the accuracy of data analysis.

Data were collected using three primary research instruments:

1. Learning Style Questionnaire:
   Developed based on the VARK model (Visual, Auditory, Reading/Writing, Kinesthetic), this questionnaire includes statements designed to identify students' preferred methods of learning and processing information. Responses are measured on a Likert scale to quantify the dominance of each learning style.
2. School Environment Questionnaire:
   This instrument covers various aspects of the school setting, including physical conditions, classroom comfort, student-teacher relationships, peer interactions, and the availability of educational facilities. Psychological aspects such as safety, communication openness, and academic support from teachers are also assessed to provide a comprehensive overview of the school learning environment.
3. Mathematics Achievement Scores:
   Academic performance data were obtained from students' end-of-semester test scores or report card grades in mathematics, which serve as the dependent variable in this study.

Before conducting the main analysis, all instruments underwent validity and reliability testing. Content validity was established through expert judgment by education professionals or experienced mathematics teachers, while reliability was assessed using the Cronbach's Alpha coefficient to ensure internal consistency across items. Once the data were collected, classical assumption tests were conducted, including normality tests (using Kolmogorov-Smirnov or Shapiro-Wilk), multicollinearity tests (via Variance Inflation Factor and Tolerance values), heteroscedasticity tests (using scatterplots or the Glejser test), and autocorrelation tests (using the Durbin-Watson statistic).

The main data analysis was carried out using the multiple linear regression technique, aimed at answering the research questions regarding the predictive power of learning styles and school environment on mathematics achievement. Partial tests (t-tests) were used to examine the individual influence of each independent variable, while simultaneous tests (F-tests) evaluated their combined effect. Furthermore, the coefficient of determination (R^2) was calculated to determine the extent to which the independent variables could explain the variance in students' mathematics learning outcomes.

Through this research method, the study aims to produce a reliable predictive model that can benefit teachers, school leaders, and policymakers. Such a model not only reveals statistically significant relationships but also provides practical insights into the importance of understanding students' learning preferences and cultivating a supportive school environment as essential strategies for enhancing the quality of mathematics education.

RESULTS AND DISCUSSION

The results of the study, analyzed through multiple linear regression, reveal that both learning styles and the school environment exert a statistically significant influence on students' achievement in mathematics. The coefficient of determination (R^2) for the regression model is 0.532, indicating that 53.2% of the variance in mathematics learning achievement among students can be explained jointly by their learning styles and the school environment. This shows a moderately strong model fit and suggests that these two variables are meaningful predictors. The remaining 46.8% of the variance may be attributed to other factors not included in the study, such as parental involvement, student motivation, prior knowledge, teacher competence, or curriculum design.

The partial regression analysis (t-test) results indicate that both predictors independently and significantly influence the outcome variable. The learning style variable obtained a t-value of 3.421 and a p-value of 0.001, meaning that it has a significant effect on mathematics achievement at a 95% confidence level. This implies that the way students prefer to learn whether visually, auditorily, through reading/writing, or kinesthetically has a measurable impact on their understanding and mastery of mathematical concepts. Educators who design instruction that aligns with these preferences may significantly improve student performance.

Meanwhile, the school environment variable demonstrated an even stronger effect, with a t-value of 4.057 and a significance level of 0.000. This highlights the crucial role of external factors such as the physical condition of the school, classroom management, teacher support, the availability of learning resources, and the overall psychological climate of the learning environment. Students who reported studying in well-structured, clean, supportive, and resource-rich schools consistently achieved better outcomes on mathematics assessments than those in less favorable environments.

The simultaneous test (F-test) for the model produced an F-value of 23.681 with a significance level of 0.000, confirming that both learning styles and school environment variables together significantly predict students' mathematics learning achievement. This collective impact reinforces the importance of considering both internal cognitive factors and external environmental conditions when analyzing student performance.

Looking at the standardized beta coefficients in the regression model, the school environment variable had a higher standardized coefficient ($\beta = 0.468$) compared to the learning style variable ($\beta = 0.377$). This suggests that although both variables are important, the school environment has a slightly greater influence on mathematics achievement. This finding aligns with other research that emphasizes the pivotal role of a safe, structured, and stimulating learning environment in enhancing student outcomes, especially in cognitively demanding subjects like mathematics.

Additionally, descriptive analysis of the data revealed specific patterns. Students with dominant visual and kinesthetic learning styles tended to perform better in classrooms that utilized diagrams, visual representations, manipulatives, and hands-on activities. This confirms the theoretical assumption that student engagement increases when the instructional method matches their preferred learning style. On the other hand, students who learned in schools with strong teacher-student communication, access to learning aids such as whiteboards, projectors, and mathematical models, and a culture that encourages inquiry and collaboration showed consistently higher test scores and reported greater satisfaction in their learning experiences.

These results suggest the need for a differentiated and responsive approach to teaching mathematics, one that acknowledges the diversity of student learning preferences and optimizes the learning environment. School administrators, curriculum developers, and policymakers should take these findings into account when designing instructional programs, teacher training initiatives, and school infrastructure improvements. The integration of learner-centered pedagogy and environmental enhancements could produce a synergistic effect that improves not only mathematics achievement but overall academic success.

In conclusion, the multiple regression analysis conducted in this study confirms that both learning styles and the school environment are significant and complementary factors in predicting students' mathematics performance. The predictive model derived from this study provides an evidence-based framework that can guide educational interventions aimed at increasing achievement, reducing disparities, and promoting equity in learning outcomes particularly in mathematics, a subject that is foundational to science, technology, and future workforce development.

The Influence of Learning Styles on Mathematics Achievement

The significant relationship between students' learning styles and their mathematics achievement supports the growing call for personalized and differentiated instruction in contemporary classrooms. In traditional models of education, teachers often rely on uniform teaching methods typically auditory or lecture-based approaches that may inadvertently disadvantage learners who process information more effectively through visual, reading/writing, or kinesthetic modalities. This misalignment may lead to cognitive overload, disinterest, or even mathematics anxiety, especially in students who require more hands-on or visual representation of abstract concepts.

Recent technological advances have made it more feasible to implement multimodal teaching strategies that cater to diverse learning preferences. The integration of digital platforms (e.g., GeoGebra, interactive whiteboards, learning management systems) allows teachers to provide visual demonstrations, auditory explanations, simulations, and tactile experiences within the same lesson (Mills et al., 2020). In the Indonesian context, where student diversity is particularly high across urban and rural schools, applying such multimodal approaches becomes crucial in bridging achievement gaps. Furthermore, awareness of learning styles not only benefits students academically but also promotes metacognition, enabling learners to reflect on their learning process and adopt more effective strategies for problem-solving in mathematics.

The Dominant Role of School Environment

Beyond individual characteristics, this research reaffirms that the school environment is a powerful lever of educational equity. Students from under-resourced schools often face barriers such as overcrowded classrooms, insufficient learning materials, low teacher morale, and unstable learning climates all of which can undermine motivation and inhibit academic success. In contrast, supportive school environments that are rich in structure, discipline, social-emotional safety, and academic scaffolding foster not only cognitive development but also emotional resilience.

This is particularly relevant in Indonesia, where disparities between urban and rural schools remain a persistent issue. According to a 2023 report by the Ministry of Education, schools in rural regions still suffer from infrastructural deficits and teacher shortages, which in turn affect students' outcomes in high-stakes subjects like mathematics. As shown by this study, students perform better in schools where teachers demonstrate care, classrooms are orderly, and learning materials are readily available. This implies that improving school environments is not merely about physical renovation, but also about fostering a culture of high expectations, mutual respect, and academic excellence all of which contribute to a fertile ground for mathematical thinking.

The Interplay Between Internal and External Factors

One of the most profound insights from this study is the interactive effect between student-centered variables (learning styles) and environment-centered variables (school climate). This interaction suggests that students with favorable learning traits may still underperform if placed in unsupportive environments, and conversely, that supportive environments can mitigate the disadvantages experienced by students with less dominant learning preferences or low self-efficacy. This reflects the transactional view of learning, where learners are not passive recipients but active constructors of knowledge influenced by their surroundings.

Studies by Rahman et al. (2021) highlight that student engagement mediated by factors like teacher feedback, peer support, and classroom safety is a critical bridge connecting internal disposition and external stimuli. In such a framework, learning styles act as predispositional filters, while the school environment provides the stimuli that either activate or suppress these learning potentials. Therefore, policy efforts that target only one dimension (e.g., curriculum or student motivation) may yield limited results. A whole-child, whole-school approach is more likely to produce sustainable learning outcomes, particularly in STEM subjects that require both individual persistence and collaborative learning structures.

Implications for Educational Practice and Curriculum Design

The implications of these findings are far-reaching for teacher training, curriculum design, and school leadership. Teachers need to be equipped not only with content mastery but also with pedagogical agility that allows them to recognize and adapt to the learning styles of their students. Professional development programs should include modules on classroom differentiation, universal design for learning (UDL), and socio-emotional teaching strategies. Furthermore, school leaders should prioritize the cultivation of a learning ecosystem that promotes academic rigor alongside emotional well-being.

In terms of curriculum, the current national mathematics syllabus could be enhanced by embedding contextual learning tasks, culturally relevant examples, and real-world problem scenarios that connect abstract math concepts to students' lived experiences. This is especially effective in motivating students from marginalized backgrounds, as it reinforces the relevance and applicability of mathematics in their everyday lives. Additionally, schools should establish feedback loops that allow students to express their learning needs and preferences, thereby fostering a student voice culture in decision-making.

CONCLUSION

This study concludes that both learning styles and the school environment are significant predictors of students' mathematics learning achievement. Through multiple linear regression analysis, it was found that these two variables jointly explain a considerable proportion of the variance in student performance, with the school environment having a slightly stronger influence than learning styles. This highlights the dual importance of internal learner factors and external educational conditions in shaping academic outcomes. The results suggest that while students' individual learning preferences play a crucial role in how they absorb and apply mathematical concepts, the broader context of the school such as physical infrastructure, emotional support, classroom management, and resource availability plays an equally, if not more, decisive role. Therefore, improving mathematics achievement requires a comprehensive approach that integrates personalized learning strategies with systemic improvements in the school environment. The predictive model derived from this research can serve as a valuable framework for educators, school leaders, and policymakers in designing targeted interventions that foster equitable and effective mathematics education.

LITERATURE

Al-Mutairi & Bennour (2022). "A multilevel analysis of Saudi Arabian student 8th grade mathematics achievement TIMSS 2011". *ArXiv* arXiv

Altamimi, Azzeh & Albashayreh (2022). "Predicting students' learning styles using regression techniques". *ArXiv* Jurnal UPSI+13arXiv+13arXiv+13

Asia Pacific Ed. Rev. (2023). "Predicting academic success: machine learning analysis … OLS benchmark". *Springer* SpringerLink

Carlogger (2022). "Influence of environment and mathematical learning styles on students' GPA…". *Jurnal Riset Pendidikan Matematika*, 9(2). PDF tersedia Sciendo+3Jurnal UNY+3Jurnal UPSI+3

Grande, Lingo & Lingo (2023). "A multiple linear regression model of students' performance in calculus in the new normal". *JRPPTTE*, Vol. 13(1). DOI: 10.37134/jrpptte.vol13.1.8.2023 Jurnal UPSI

Li (2024). "A Study on the Relationship between Multiple Regression Analysis and Students' Achievement Improvement … English Teaching". *Applied Math & Nonlinear Sciences*, 9(1). DOI available IJEMST+8Sciendo+8Literasi Sains+8

McClain & North (2021). "Effect of Technology Integration on Middle School Math Proficiency: A Multiple Linear Regression Study". *IJEMST*, 9(4), 557–570. DOI: 10.46328/ijemst.1456 IJEMST+1Ijemst+1

MDPI (2021). "The Relationship between Learning Styles and Academic Performance …". *Sustainability*, 13(6):3341 MDPI

Moser & Wilson (2023). "Effects of Learning Styles on Academic Achievement in a Middle School … Science Classroom". *Amer. J. Educational Rsch.*, 11(1). DOI: 10.12691/education-11-1-1 Science and Education Publishing

Orji & Vassileva (2022). "Machine Learning Approach for Predicting Students Academic Performance and Study Strategies …". *ArXiv* arXiv

Özer & Co-authors (2022). "Influence of School Factors on Students' Mathematics Achievements … TIMSS 2015". *Education Sciences (MDPI)* MDPI+1SpringerOpen+1

Pizon & Ytoc (2021). "A Path Model to Infer Mathematics Performance: … learning style …". *ArXiv* arXiv

Saragih, Gunawan & Parlina (2023). "Implementation of the Multiple Linear Regression Method to Predict Student Achievement Based on Social Status and Discipline". *JOMLAI*. DOI: 10.55123/jomlai.v2i2.3128 Literasi Sains

Tomul et al. (2021). *The role of school location, family and student factors* – multiple linear regression via TIMSS data SpringerOpen

Tomul, Önder & Taslidere (2021). "The relative effect of student, family and school-related factors on math achievement by location of the school". *Large-scale Assessments in Education*, 9:22. DOI & PDF tersedia secara open access Sciendo+3SpringerOpen+3Literasi Sains+3