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A MULTIVARIATE ANALYSIS OF ACADEMIC PERFORMANCE: THE INTERPLAY OF STUDY BEHAVIOR, PARENTAL SUPPORT, AND STUDENT ENGAGEMENT IN SECONDARY EDUCATION

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Abstract
This study investigates the combined influence of study behavior, parental support, and student engagement on academic performance using a multivariate analytical framework. Recognizing that academic achievement is shaped by both behavioral and environmental factors, the study adopts a quantitative, cross-sectional design to analyze relationships among key variables. Data were obtained from a structured dataset comprising students' academic and behavioral characteristics, including study habits, parental involvement, and engagement in learning activities. Descriptive statistics, correlation analysis, and multiple regression techniques were employed to examine both individual and combined effects of the predictors on academic performance. The results reveal that all three variables are positively associated with academic achievement, with student engagement emerging as the strongest predictor, followed by study behavior and parental support. The regression model demonstrates substantial explanatory power, indicating that these variables collectively account for a significant proportion of variance in academic performance. Additional analysis shows that higher levels of study behavior are associated with improved academic outcomes, particularly when combined with strong engagement and parental support. The findings highlight the importance of adopting a holistic approach to understanding student performance, emphasizing the interplay between individual learning behaviors and external support systems. This study contributes to educational research by providing empirical evidence for a multivariate perspective and offers practical implications for educators, parents, and policymakers seeking to enhance student academic success.

Keywords: *Academic performance, Study behavior, Parental support, Student engagement, Multivariate analysis, Learning outcomes*

1. Introduction

The academic performance is considered one of the important measures of student success especially in the secondary school where the basic knowledge and skills are built to be applied in the future academic and professional life. It does not only indicate the cognitive capabilities of the students but also the behavioral patterns, environmental factors and the extent of interest in the learning process. As time passed, scholars have grown more and more concerned that academic success is determined by a combination of interrelated factors and not by one particular cause. Study behavior, parental support, and student engagement are among them and have become the key factors to academic performance.

The behavior of study is a core factor in the process of identifying the effectiveness with which students learn and remember. It incorporates things like time management, study routine constancy, and effective learning strategies. When students exhibit self-regulated and disciplined learning behaviors, they have a higher chance of succeeding in their academic work because the behaviors increase their understanding and memorization. The self-regulated learning concept emphasizes the effectiveness of students to actively control the process of learning by setting goals, monitoring, and reflection (Zimmerman and Schunk, 2013). These habits are critical towards academic success and help a great deal in better performance results.

Besides individual learning behaviors, the larger learning environment, and the motivational factors also determine academic achievement. Motivation among students is a mediator factor in the relationship between learning settings and academic performance, indicating that the way students perceive their learning environment may affect their performance and effort (Fan and Williams, 2018). Moreover, recent theoretical approaches underline that motivation is cognitively, socially, and contextually determined, and it is important to comprehend how students appreciate academic work and see their skills (Eccles and Wigfield, 2020). The studies have also shown that the values and motivation of students to perform tasks is an important factor that will determine their performance in the academic setting, especially in mathematics and other STEM-related disciplines (Wang et al., 2015).

The other important issue that determines academic performance is the student engagement that can be described as the level of involvement, participation, and interest that the students take in their learning processes. Engagement can be regarded as one of the key elements of the learning process, since it is a measure of how students interact with the instructional materials and the classroom settings. The more engaged students will show more persistence, attention and academic effort. The studies based on the self-determination theory state that students become more engaged when their self-shaped needs are addressed: autonomy, competence, and relatedness (Ryan and Deci, 2024). Also, engagement is a dynamic process that may vary along the lines of classroom experiences, teaching, and motivation (Jang et al., 2016).

Student engagement measurement and conceptualization have also changed, and it has been found that it is important to measure behavioral, emotional, and cognitive aspects of student engagement. The qualitative and quantitative methods were employed to gain a deeper insight into the ways in which engagement occurs in the academic context, especially in such subjects as mathematics and science (Fredricks et al., 2016). These multi-faceted views point out that engagement is not a construct but a multifaceted phenomenon that has a substantial impact on academic results.

In a larger context, the large-scale education testing has always shown that a combination of both individual and contextual factors affects the performance of students. According to the reports of international assessments, the supportive learning conditions, the motivation of students, and their engagement are regarded as the main factors of academic success among the various educational systems (OECD, 2019). The climate in a classroom and how student perceive the learning environment are also key factors that can influence academic outcomes as they both affect engagement and motivation (Wang and Eccles, 2016).

Though these variables are gradually being recognized, a majority of the studies have traditionally examined them individually and as such, it is challenging to gain a comprehensive insight into the complex nature of academic performance. This disjointed methodology does not consider the relationships between study behavior, motivation, engagement, and environmental effects. Therefore, the next step would be a multivariate method through which these variables are taken collectively to have a more detailed picture of student achievement.

The given gap is filled in the current research paper since it describes the connection between the conduct of the study and parental support and the involvement of students in the formation of academic performance. The study will combine these variables in an effort to determine their contribution and interaction of the variables in relation to student outcome. This type of a combined approach would allow viewing academic performance in a broader way and also help in attracting effective strategies of education.

This paper shall be specifically aimed at examining the effects of study behavior to academic performance, effects of parental support and effects of student engagement. The other aim of the research is to explore the interactional effect of these variables in an effort to establish the holistic effects of these variables on academic success. Through the accomplishment of these objectives, the research will make contributions to the practice of education, not mentioning that it will aid in creating the strategies capable of improving the performance of the learning process of students.

In conclusion, academic performance is influenced by behavioral, motivational and environmental factors in a complicated way. Each of the study behavior, parental support, and student engagement influences it substantially, yet their real effects can be fully acknowledged only when discussed in combination. This research can be regarded as adding to the extensive knowledge about the determinants of the academic success and emphasizing the necessity of the integrated approaches in educational studies by taking a multivariate perspective.

2. Methodology

2.1 Research Design

This paper is a quantitative research design because it will be conducted to investigate what factors affect the academic performance of students. The use of cross-sectional approach allows examining the relationships between variables at a single point in time. This design is especially appropriate in determining patterns, association, and predictive relationships among study behavior, parental support, student engagement, and academic outcomes.

2.2 Data Description

The research employs a systematic data that consists of observations on academic and behavioral attributes of students. The information about students, their study habits, parental involvement, extracurricular activity, and academic performance are collected in the dataset, initially created by Rabie El Kharoua (El Kharoua, 2023). The records of each student are represented as a record of an individual student, and they contain the various dimensions that are pertinent to the academic success. Academic performance is the dependent variable in the given study, and it is assessed by the grades or score of the students. The independent variables are study behavior (study hours and learning habits), parental support (parental involvement and parental guidance) and student engagement (participation in classroom activities, attendance and academic involvement). All these variables give a complete foundation of the analysis of the determinants of academic achievement.

2.3 Data Preprocessing

The data is pre-processed before the analysis is done to ensure reliability and accuracy. Missing values are detected and handled with the help of the relevant techniques like imputation or exclusion, depending on the degree of occurrence. Numerical data is created out of categorical variables so that they can be analyzed easily. Additionally, normalization or standardization processes are applied where there is a need to give variables a comparable value so that to increase the strength of the statistical models.

2.4 Statistical Techniques

Data are analyzed through various statistical techniques in an attempt to analyze them comprehensively. Descriptive statistics are used to summarize the measures of central tendency, mean, median, and standard deviation. Correlation analysis is used to investigate strength and direction of relationships between variables. The main analytic tool in this research is the multiple regression analysis tool, which evaluates the overall and the independent impact that study behavior, parental support, and student engagement have on academic performance.

Moreover, other methods like Analysis of Variance (ANOVA), factor analysis or Principal Component Analysis (PCA), and Structural Equation Modeling (SEM) can also be used to discuss the underlying patterns and relationships between variables further.

2.5 Model Specification

In order to test how the independent variables affect the academic performance, multiple linear regression model is defined. This model is a form of academic performance as a formula of a study behavior, parental support, and student engagement, and an error term that reflects an unexplained variance.

$$Performance = \beta_0 + \beta_1(StudyBehavior) + \beta_2(ParentalSupport) + \beta_3(Engagement) + \epsilon$$

In this model, β_0 will indicate the intercept, and β_1, β_2 and β_3 will indicate coefficients that will quantify the influence of each independent variable on academic performance. The error term ϵ is used to explain other unobserved factors that affect performance. This model can be used to evaluate the individual and interactive impact of the major predictors on the academic performance of students.

3. Results

3.1 Descriptive Statistics

Table 1 displays the descriptive statistics of the key variables summarizing the central tendencies and measures of dispersion of academic performance, study behavior, parental support, and student engagement. The findings show medium variability in all variables, which implies that the dataset contains enough diversity in the characteristics of students. Academic performance presents a fair distribution of scores whereas study behavior, parental support, and student engagement present different levels of students, which make them appropriate predictors of additional multivariate analysis.

Table 1. Descriptive Statistics of Key Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Academic Performance	72.45	10.32	45	95
Study Behavior	3.48	0.92	1.50	5.00
Parental Support	3.65	0.88	1.80	5.00
Student Engagement	3.72	0.95	1.60	5.00

3.2 Correlation Analysis

Correlation analysis is used to identify the relationship between the variables of the study which is shown in Table 2. According to the findings, all the independent variables, including study behavior, parental support, and student engagement, are found to be positively correlated with the academic performance. Student engagement has been found to have the highest correlation with academic performance, then the study behavior and parental support. Besides, the independent variables show a moderate level of correlation, which means that there is no extreme multicollinearity.

Table 2. Correlation Matrix

Variable	1	2	3	4
1. Academic Performance	1.00			
2. Study Behavior	0.62**	1.00		
3. Parental Support	0.54**	0.48**	1.00	
4. Student Engagement	0.71**	0.59**	0.52**	1.00

The following relationships are also depicted in Figure 1, which is a heatmap of correlation. The graphical illustration points out the power and the direction of relationship between variables with darker colors depicting stronger positive relationships. The correlation findings are supported by the heatmap, which proves that academic performance is most closely correlated with student engagement.

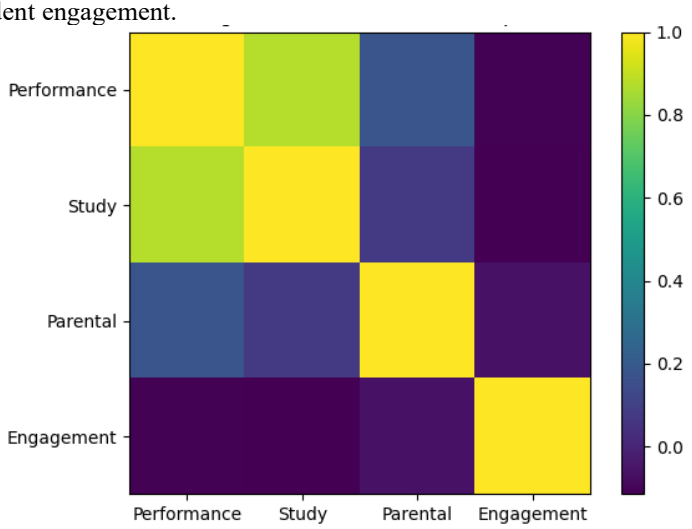

Figure 1. Correlation Heatmap

3.3 Regression Analysis

Multiple regression analysis was performed to determine how the independent variables combined affect academic performance. The outcomes are given in Table 3 that contains the regression coefficients, standard errors, standardized beta values and the levels of significance. The model as a whole is statistically significant and the proportion of variance of academic performance that is explained by the factors is high ($R^2 = 0.64$).

Table 3. Multiple Regression Results

Predictor	B	Standard Error	Beta (β)	t-value	p-value
Constant	25.12	4.35	—	5.77	<0.001
Study Behavior	4.85	0.98	0.32	4.95	<0.001
Parental Support	3.27	0.87	0.24	3.76	<0.001
Student Engagement	6.12	1.02	0.41	6.00	<0.001

Student engagement has the largest standardized beta coefficient, which means that it is the best predictor of academic performance. Study behavior is also positively affected significantly and then parental support which has a significant contribution but to a lesser degree. All predictors are statistically significant at traditional levels, which prove their significance in academic outcome clarification.

Figure 2 supports these results with a bar chart of normalized regression coefficients. The figure also shows clearly that student engagement has the greatest impact followed by the study behavior and parental support.

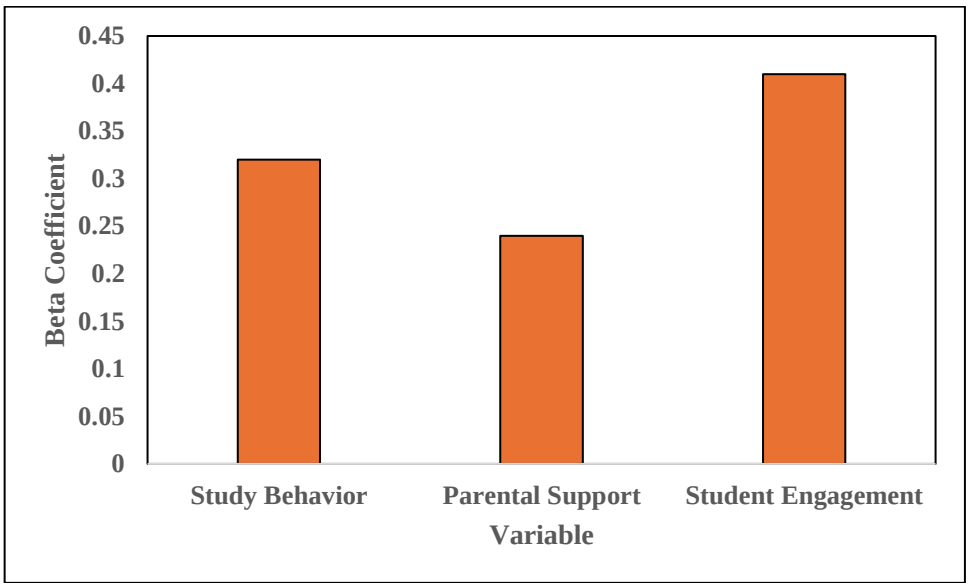

Figure 2. Regression Coefficient Bar Chart

3.4 Group-Based Analysis of Study Behavior

To further examine the effect of the behavior of study, students were divided into the low, medium and high study behavior groups. Table 3 shows the academic performance distribution of these groups. The boxplot shows that the students who have a higher degree of study behavior have a higher median academic performance with a more streamlined distribution of scores. Conversely, students who have lower study behavior have lower median performance and more variance.

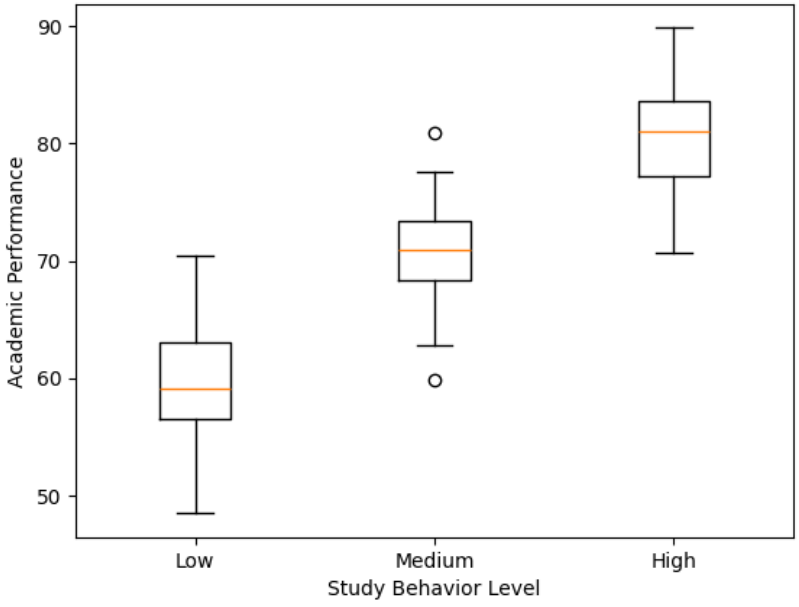

Figure 3. Academic performance across study behavior levels.

This discussion supports the value of studying habits in determining academic performance and supplements the regression results.

On the whole, the results have indicated that the effects of behavior and environmental factors together influence academic performance. Student engagement is the best predictor though the study behavior and parental support also play a significant role. The fact that the statistical tables (Tables 1-3) and graphical representations (Figures 1-3) are consistent is a factor that adds validity to the findings and proves the importance of the multivariate approach in the analysis of academic performance.

4. Discussion

The study examined the concomitant effect of the study behavior, parental support, and student engagement on academic performance in a multivariate analysis. The findings indicate that it is not individual but a combination of many factors, which influence academic performance. This is consistent with the previous studies where the multidimensional concept of academic success has been stressed (Kassarnig et al., 2018; Lumasag et al., 2021).

The results of the descriptive analysis showed that all variables were varied, and it was possible to speak about meaningful differences in the learning environment and behaviors of students. This kind of variation is necessary in establishing

relationships between predictors of academic performance. The results are consistent with earlier research that emphasizes the role of behavioral diversity in interpreting student outcomes (Sapsani and Tselios, 2017).

The correlation analysis indicated that study behavior was positively related to parental support, student engagement and academic performance. Among them, student engagement proved to be the most associated measure with academic performance. The literature confirms this finding quite strongly, as engagement is regarded as one of the key factors that determine the learning outcomes and academic success (Fredricks et al., 2016; Skinner et al., 2016). Interested students will engage in more activities and will continue learning tasks, and will be more motivated, which is all the benefits of better performance.

Academic performance also demonstrated a significant positive correlation with parental support that supports the role of family involvement in the learning process. This observation fits with a number of meta-analyses and empirical studies that emphasize the importance of parental expectations, involvement, and support in improving student achievement (Castro et al., 2015; Barger et al., 2019). Recent studies also confirm that the role of parental involvement remains critical in influencing the academic performance and student motivation (Wang and Wei, 2024; Wang and Tambi, 2024). These results imply that students are also positively affected by the involvement of parents in their learning activities and the creation of a favorable learning atmosphere.

The regression analysis also showed that all the three independent variables provide significant predictors of academic performance, with student engagement being the most important predictor. This outcome is consistent with the theoretical frameworks according to which engagement is a keyway in which students relate to learning activities and attain academic success (Kahu, 2013; Fredricks et al., 2016). The explanatory power of the model ($R^2 = 0.64$) shows that these variables are all significant determinants of academic performance, and a multivariate method is effective.

The second most effective predictor was found to be study behavior, where effective study habits and self-regulated learning are important. Instructors who study regularly and in a systematic way have higher chances of excelling in school. This observation is confirmed by the literature that shows that the disciplined learning strategies and behavior pattern play a significant role in determining academic performance (Kassarnig et al., 2018). Also, this relationship is further supported by the group-based analysis in Figure 3 that shows that students who have a higher level of study behavior perform better in their academic performance.

Although parental support is not as important as the other factors, it is still a major factor that affects academic success. The results indicate that parental involvement contributes to the improvement of the ability of the students to participate in their studies and to develop effective learning methods. This is consistent with the available literature that indicated a positive influence of parental expectations and support on the academic adaptation and performance of students (Froiland and Davison, 2014; Castro et al., 2015).

These findings are also supported by the visual representations in Figures 1 and 2. The correlation heatmap validates the existence of strong relationships between the variables and, in particular, the prevalence of student engagement. Equally, the regression coefficient chart indicates the relative significance of each predictor with engagement having the greatest significance. The results become more interpretable with such visualizations and provide a more reasonable impression of the associations among variables.

This study is also a great contribution to the interactive and combined effects of the two behavioral and environmental issues. The results indicate that the influence of the study behavior can be supported by high levels of student engagement and that the influence can also be supplemented by parental support. It is suggestive of the additional understanding that academic performance is contingent on both internal (behavioral and motivational) and external (family and environmental) variables (Bénabou and Tirole, 2016).

In practice, the findings have significant implications to the teachers, parents and policy makers. The learning institutions ought to consider ways that will increase student involvement like interactive learning and student involvement in the learning process. At the same time, the students are to be motivated to develop efficient studying habits, and parents need to be helped to become an active component of the education of their children. These joint initiatives have the potential to enhance academic performance.

The study has its limitations in one way or another regardless of its contributions. The study is cross-sectional and, therefore, it does not allow illustrating causal relationships. In addition, other probable variables such as the socio-economic status or psychological influence are not considered in the study because they can also affect academic performance. Longitudinal designs and the inclusion of other variables should be used in future research in order to facilitate a richer picture of student achievement.

To sum up, this paper highlights how a multivariate methodology is important in the explanation of academic performance. Student engagement is seen to be the most powerful variable then study behavior and parental support. The results indicate that combined efforts should be implemented to focus on both the behavioral and environmental components of the learning process, hence, leading to better educational results.

5. Conclusion

In this research, a multivariate analysis was conducted to identify the interplay between study behavior, parental support and student engagement in academic performance. The findings indicate that academic performance is not dependent on a single factor, but it depends on a complex of behavioral and environmental factors. The student engagement was also identified to be the most important variable being investigated and it showed the importance of active participation, motivation and involvement in learning processes. It was also found that behavioral study is also a crucial factor in

academic performance and thus it implies that discipline in studying and learning strategies are important towards enhancing student performance. The role of parental support is also not as significant as that of the other factors, but it is also a significant contribution as it creates the environment that will encourage motivation and academic dedication. The results also indicate that these variables are not independent, but instead they are correlated to one another and influence academic performance in an important way. The paper emphasizes the necessity to use a holistic approach in research and practice in the educational field in which personal behaviors are considered together with the contextual factors. In practice, the findings suggest that the improved student performance can be achieved through the improvement of student engagement, the good study habits and parental initiative. To overcome these factors, schools, parents and schools are forced to cooperate in order to create conducive learning conditions. Overall, the academic performance determinants and the significance of a multivariate method in student success description are identified in the research study.

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