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# Multivariate Statistical Analysis of Influencing Factors of Student Achievement

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**Abstract:**

The performance of students has a close relationship and far-reaching impact on the long-term development of the entire education community. It is not only related to objective factors such as the school's teaching style and teachers but also to students' families and personal factors. This article aims to study the factors that affect students' performance. This article selects 500 students, uses questionnaires to obtain data, and then selects about 100 students from 500 people for further quantitative survey. The scoring system is adopted, allowing these students to choose the influence of factors that affect their academic performance to score, and then linear regression is adopted. The model is analyzed and the results are obtained. The results show that learning environment, learning habits, psychological state, family education, and IQ have a relatively high correlation with students' grades. Student grades not only involve the living standards of students and parents but also have a close relationship with the whole society.

**Keywords:** student performance, multivariate linear regression, influencing factors

## 1. Introduction

Students' performance is a direct reflection of students' learning situation and is affected by a variety of factors, including students' learning initiative, students' overall quality, teachers' teaching level, school management mode, etc. Tu's research shows that student performance is closely related to students' learning quality [1]. The quality of students' learning has a significant impact on the national education level, so their academic performance is particularly concerned.

Starting from the parental factors in the family reasons, Pang selected 8 explanatory variables and conducted empirical analysis through sampling [2]. The results show that the main driving force for the increase in students' grades is the education level and family relationship of parents, which provides a basis for the formulation of education policies. Similarly, through a multi-level analysis of the factors affecting students' academic performance, Yan found that the variables valued by educators, such as school size, class quota, school hardware resources, and scientific activity participation index, did not have much impact on academic performance. On the contrary, the student's family social and cultural status index,

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learning Motivation, classroom discipline atmosphere, teaching style, the negative behavior of teachers and students, etc. have an impact on students‘ grades [3].

Li adopted the method of principal component analysis to conduct a statistical analysis of the survey data. Statistics show that the three main components that affect students' math scores are learning attitude, learning motivation, and learning anxiety [4]. Gu understands the possible factors affecting the performance of college students through market surveys and collects relevant data, including learning time, parents‘ occupation, the number of truancy and other factors, and establishes a multivariate regression analysis model for data analysis and prediction, and finally compares the analysis and prediction results of several models [5]. Gu's research results show that learning time is a very important factor, which is of great help to improve student efficiency. Zhao uses the mechanical decision tree algorithm in data mining to fit the data model for the original data selection, feature classification, and data and processing normalization [6].

This provides a new way for schools to evaluate educational results. Zhou studies the factors affecting students' grades, does not consider the fixed situation of teacher factors for analysis, nor does he consider the subjective will that is difficult to observe, such as the degree of preference for the course, the willingness to learn, and the motivation of interest and enthusiasm, etc., only selects and analyzes, and the school can observe and quantify the influencing factors [7]. When Zhang has the link of online teaching, the project-based practical teaching promotion method has a significant impact on students‘ final grades [8].

From the empirical data analysis, Shao, there is no significant difference between the academic performance of students enrolled in cram school and those who did not attend cram school. The school should be the main responsibility of teaching and should return to school [9]. Chen's research results show that in the teaching process, high school mathematics teachers should pay attention to the cultivation of students‘ psychological quality, improve students' interest in mathematics learning, and then improve students‘ academic performance. At the same time, in the actual teaching process, teachers should carry out different psychological guidance for different students [10]. However, there are still some shortcomings in the existing research. Most studies only focus on the impact of objective factors on students' performance, but ignore the relevance of students‘ performance to students themselves. This paper uses the method of linear regression to analyze the main factors affecting students' academic performance in combination with sampling and investigation, aiming to effectively improve students‘ grades.

# 2. Methodologies

## 2.1 Overview of Student Achievement Research

Research on student achievement has gone through several stages, and with the continuous development of educational technology and statistical methods, the relevant studies have gradually deepened. Many studies have focused on individual factors such as intelligence, family background, and motivation. Intelligence is usually quantified by IQ tests, and many studies have shown that there is a significant positive correlation between IQ and academic achievement, with correlation coefficients ranging from 0.3 to 0.6 [11]. Family background factors, such as parental education and economic status, have also been identified as important influences. Studies have shown that for each increase in parental education level, students performance improves by an average of 10-15 points [12].

As we enter the 21st century, educational
research has begun to introduce multivariate statistical analysis methods to more fully understand the influencing mechanisms behind achievement. Studies have found that learning strategies and classroom engagement have a significant impact on academic achievement[13]. In addition, mental health and emotional management have also been recognized as emerging factors affecting academic performance [14]. Studies addressing the educational environment are also relatively rich. In recent years, some scholars have explored the relationship between school environment, teacher support, and student achievement through hierarchical linear model analysis. The results of the study showed that good teacher-student relationships and a positive school climate can effectively enhance students academic performance [15].

In summary, research related to student achievement has gradually shifted from single-factor analysis to multidimensional comprehensive consideration, emphasizing the complexity and diversity of academic achievement. Future research is expected to deeply analyze the internal and external factors affecting student achievement by integrating more variables and adopting advanced statistical methods.

## 2.2 Research Methodology

Multivariate statistical methods are used to explore the relationship between multiple variables to reveal potential factors affecting student achievement. Regression analysis is mainly used to model the relationship between the response variable and multiple explanatory variables.

Typical correlation analysis is used to analyze the relationship between two sets of variables, such as students' psychological characteristics and academic performance. The strength of the linear relationship between two groups of

variables is assessed by calculating the typical correlation coefficient. A typical correlation coefficient higher than 0.5 is often regarded as a significant correlation, which can effectively reveal the joint effect of different dimensions on academic performance.

This paper uses a questionnaire to collect data from nearly 500 students in the form of a paper questionnaire on the topic of the factors that most affect grades in students minds. The results of the survey are shown in Figure 1, in which IQ, study habits, learning environment, psychological state, and family environment are the five options chosen by the largest number of people, and the number of people who chose these factors is nearly 350, accounting for about seventy percent of the total number of people.

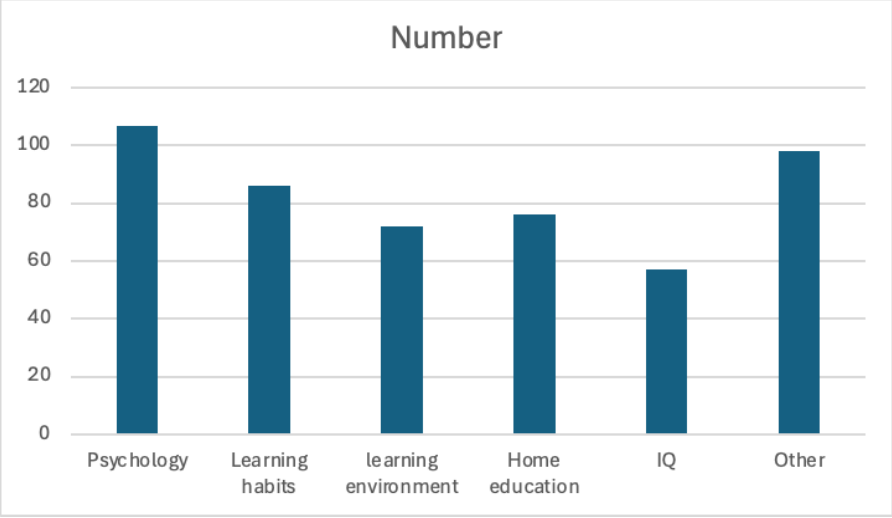


**Fig. 1 The main factors affecting psychological (Photo/Picture credit: Original).**

## 3. Results

To explore the influence of multiple independent variables on the dependent variable,100 students out of 340 were selected for further quantitative questionnaires. Students were asked to self-assess their psychological state on a scale of 1 to 5 out of 5, with 5 being relatively good and 1 being poor, and the collected data were analyzed by multiple linear regression, as shown in Table 1. The sample size of 100 students ensured the breadth and representativeness of the data.

**Table 1. Coefficients for multiple influencing factors**

| Model B | | Regression weights | | Standardized regression weights | t | Significance Tolerance | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | S t d . Error | Beta | | | | VIF | |
| 1 | (Constant) | .497 | .454 | | 1.094 | .277 | | |
| | IQ | .293 | .068 | .174 | 2.331 | .200 | .863 | 1.158 |
| | family education | .280 | .103 | .175 | 2.708 | .008 | .821 | 1.218 |
| | learning environment | .137 | .089 | .100 | 1.538 | .128 | .817 | 1.225 |
| | study habits | .560 | .087 | .471 | 6.469 | .000 | .650 | 1.538 |
| | psychological state | .207 | .090 | .178 | 2.291 | .024 | .666 | 1.501 |
| a. Dependent Variable: academic performance | | | | | | | | |

The data analysis tools used were Excel and related data analysis libraries for data processing and analysis. The final sample data used for multivariate statistical analysis included students performance in various subjects and information related to the learning environment, study habits, and psychological factors, which were expected to provide a comprehensive perspective revealing the combined effects of various factors on students' performance.

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Multiple linear regression analysis was used to explore the effects of the factors on student achievement. The specific model was:

$$academicperformance = \beta 0(constant) + \beta 1(studyhabits) + \beta 2(psychologicalstate) + \beta 3(familyeducation) + \beta 4(IQ) + \beta 5(learningenvironment) + \epsilon(errorterm)$$

. As shown in Table 2, the R2value of the model through regression analysis was 0.67, indicating that about 67% of the variance in achievement can be explained by these explanatory variables.

**Table 2. Model Summary B**

| Model | R | R square | Adjusted R Square | Std Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .822a | .676 | .659 | .81739 | 1.756 |
| a. Predictors: (constant), psychological state, learning environment, IQ, family education, and study habits. | | | | | |
| b. Dependent Variable: academic performance | | | | | |

In the regression results, study habits and psychological state have a significant effect on students' performance, as shown in Table 1, with regression coefficients of 0.47 and 0.18, indicating that students with better study habits and psychological state generally have higher academic performance. The regression coefficient of the learning environment is 0.1, which has a smaller effect but still shows a positive correlation. In addition, the effects of IQ and family education on achievement were also more significant, with regression coefficients reaching statistical significance.

The data analysis was also validated using analysis of variance (ANOVA)to facilitate our comparison of these sample means for significant differences, as shown in Table 3.

**Table 3. ANOVN test**

| Model | | Quadratic sum | Degree of freedom | Mean square | F | Significance |
|---|---|---|---|---|---|---|
| 1 | Regression | 131.195 | 5 | 26.239 | 39.272 | .000b |
| | Residual | 62.805 | 94 | .668 | | |
| | Total | 194.000 | 99 | | | |
| a. Dependent Variable: academic performance<br>b. Predictors:(constant), psychological state, learning environment, IQ, family education, and study habits.n ANOVN test | | | | | | |

The survey data reveal the importance of factors such as psychological state and study habits in student's academic performance, providing empirical evidence for the formulation of targeted education policies. Subsequent studies will explore more refined individual difference factors and their impact on learning outcomes. In Table 1, the VIF (Variance Inflation Factor) calculation shows that the VIF values of all variables are below 10, and there is no problem with multicollinearity.

## 4. Discussion and Suggestion

In high school, students' growth and academic performance are affected by many factors. The research results show that there is a significant correlation between family education, learning environment, learning habits, psychological state, and IQ and students' performance. Among them, as shown in Table 1, high school is a sensitive period for students. The company of parents is very necessary. A warm and loving family atmosphere is conducive to students' growth and academic performance. Schools should strengthen the cultivation of students' learning habits. The formation of good habits is a long process. The school's hardware facilities should be updated according to the needs of teaching to provide a good learning environment for students. IQ is not the most important influencing factor of academic performance. Classing according to students' IQ level will lead to students' polarization, which is not conducive to students' development, and educational balance, and hinders students' common progress.

In addition, doing more exercises is an effective way to master and consolidate knowledge. In daily teaching, students should be urged to complete their homework in time and review and consolidate their knowledge. Institutions of higher learning should follow the law of the formation of learning attitude, strive to make students have a scientific learning attitude from multiple angles, let students actively correct their learning attitude, participate in various

learnings cognitively and efficiently, improve the quality of students' learning from the main body of learning, and truly achieve the purpose of improving the quality of school management.

The impact of learning anxiety on students' performance is also worth paying attention to. Learning anxiety refers to students' emotional response to the specific learning results that reality or expectations pose a threat to their self-esteem and value in the learning process [16]. Studies on the relationship between academic performance and learning anxiety show that students with better academic performance tend to have a higher level of learning anxiety, which may be related to the higher expectations of parents and teachers for students [17]. Therefore, in education and teaching, teachers and parents should not put too much pressure on students. They should appropriately encourage and praise students, so that students can reduce their learning anxiety and make their learning easy and happy. Schools should establish some psychological counseling rooms to keep abreast of students' psychological condition. If students have psychological problems, they should provide psychological counseling in time.

Finally, parents should cultivate their children's planning ability and good learning habits from an early age. Effective planning can not only allocate time reasonably but also ensure that children study effectively and have enough time to relax and rest. With the growth of the grade, children will face more and more tasks, and the difficulty of learning will also increase. Effective planning can reduce the pressure on students and increase learning efficiency.

The advantage of this article is that it uses a sample survey to make the results more universal and convincing. The quantitative survey method can better show the degree of influence of the factors that students think affect their grades. However, there are still some shortcomings in this article, such as not using a more accurate degree of investigation, and the amount of investigation is relatively limited, resulting in some deviations in the results. In future research, we should pay attention to higher-dimensional investigation and choose a larger sample size to achieve a more comprehensive and accurate practical learning effect close to most students.

## 5. Conclusion

This paper investigates the factors affecting academic performance from the direction of multidimensional comprehensive consideration and collects data in the form of questionnaires. After a series of data analysis and research, it is found that study habits and psychological state are the two factors that most affect students' performance, and their regression coefficients are 0.47 and 0.18 respectively, which indicates that students with relatively good study habits and psychological state show relatively good performance. The remaining three influencing factors reached statistical significance and were all positively correlated with student achievement. The variance inflation factor values of the variables are all below 10, indicating that there is no problem of multicollinearity among the variables. Finally, the article gives relevant discussions and recommendations. Factors affecting students' performance are multifaceted, and multiple elements together affect students' performance and development. Schools should pay attention to the cultivation of students' study habits avoid grouping students into different classes, and update the hardware facilities of schools to provide students with a better learning environment. Families should always pay attention to the psychological state of students, and find timely solutions to avoid unnecessary problems.

There are some drawbacks in this study, the data from the questionnaire was obtained from the students' self-assessment, which could not avoid the influence of subjective factors. Moreover, the study mainly focuses on the general factors and neglects the reasons for individual factors. To solve the shortcomings, we propose the following prospects: first, expand the sample size, precise the sample of the research object, and carry out more in-depth research. Second, to increase the detailed research on individual students. The improvement of students' performance has a long way to go, and the research on students' influencing factors is still in the growth period, so we hope that more researchers will solve these problems in the future so that the education system will be more scientific and complete.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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