



Impact of Biological Factors on the Academic Performance of Students: A Comprehensive Analytical Study

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Introduction

Numerous factors, including biological elements that go beyond conventional educational paradigms, affect pupils' academic achievement. Blood type, blood genotype, and gender are among the biological characteristics that have become interesting research areas because they provide information about the complex interactions between biology and educational results. The research examines how biological characteristics, such as gender, blood type, and group, affect students' academic achievement as determined by their cumulative grade point average (CGPA). The study examines these variables' ability to predict CGPA using multiple regression analysis and decision tree regression. The findings indicate the model's weak explanatory ability, which shows a non-significant F-statistic and an R-squared value of 0.040. Nonetheless, a few factors, including blood type, gender, and specific birth months, are significant in CGPA prediction. A Mean Squared Error (MSE) of 0.2825 for the decision tree regression model indicates a satisfactory fit of the model to the data. To fully comprehend academic accomplishment, the study's conclusion emphasizes the significance of taking biological elements into account as well as other socioeconomic and psychological aspects. It emphasizes the necessity of using multidisciplinary research methods to disentangle the intricate interactions between variables influencing students' academic paths.

Methodology

This study employs a mixed-methods approach, primarily utilizing a quantitative analysis of academic data, specifically Cumulative Grade Point Average (CGPA) obtained from the Computer Science Department at the Federal Polytechnic of Ilaro, alongside a qualitative exploration of students' biological profiles and educational experiences, where data on blood type, genetic information, and gender identification characteristics were collected to serve as the research dataset; the methodology involved exploratory data analysis using statistical graphics and descriptive statistics (means, standard deviations, and frequencies presented in Table 2, with CGPA distribution visualized in Figure 1, and categorical variables like blood group, genotype, gender, and birth month represented in bar plots as shown in Table 3), followed by inferential analysis employing multiple regression and decision tree regression modeling to examine the relationships between these biological factors and academic performance, with data preprocessing revealing a dataset of 533 rows and 6 columns, comprising one continuous (CGPA) and four categorical independent variables (as illustrated in the first and last five rows of the dataset)

Result and discussion

The model explains a small 4% of CGPA variance (R-squared = 0.040). The adjusted R-squared is negative (-0.005), suggesting the model's complexity may not be justified. The F-statistic (0.8988) yields a non-significant p-value of 0.601 ($p > 0.05$). Overall, the model does not significantly explain the variation in CGPA, indicating the independent variables are likely insufficient predictors. The low R-squared and non-significant F-statistic support this conclusion. The multiple regression model, $CGPA = \beta_0 + \beta_1(MONTH) + \beta_2(BLOOD_GRP) + \beta_3(BLOOD_GNE) + \beta_4(GENDER) + \epsilon$, aims to predict a student's CGPA based on their birth month, blood group, blood genotype, and gender. This equation suggests a potential for forecasting student grades based on these biological and demographic factors.

Conclusion

The analysis explored the influence of biological characteristics—gender, blood type, and blood group—on students' academic performance, revealing notable connections. Specifically, the research identified varying degrees of correlation between blood group and genotype with academic achievement, suggesting avenues for further investigation into the underlying mechanisms. Furthermore, the study highlighted the importance of considering gender as a fundamental biological factor in academic research, as observed gender differences in academic outcomes underscore the need for educational policies promoting equity.

Keywords: Academic Performance, Biological Factors, CGPA, Decision Tree Regression