

Predicting Students' Academic Performance Using Regression Analysis

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Abstract This study generally aimed to develop a predictive model for students' academic performance. Correlational research designs were employed in this study to explore the relationships between the students' sex, course, senior high school data, admission ability test, and first-year performance of the students. A statistical model for predicting first-year students' academic performance based on admission data and first-year academic performance was formulated. The study was conducted in one of the State Universities and Colleges (SUCs) in Cordillera Administrative Region (CAR). The population of the study was 521 first-year students enrolled during the first semester and completed up to the second semester of the school year 2019-2020. From the findings, the academic performance of the students is highly associated with their high school GWA, strand, admission ability, course, and sex. The academic performance of first-year students can be predicted using Multiple Linear Regression (MLR) analysis, a model that considers the high school GWA, strand, and admission general ability, of the students as significant predictors. The derived model has a predictive power of around 67.30% and the model was found a good model. It is then suggested that the highly associated data to students' academic performance like high school GWA and admission test results can be considered in the recruitment and admission of students, especially, in the programs with board examinations. The same predictors are suggested to be accommodated in developing programs and interventions which could improve the student's academic performance. Meanwhile, the administrators are encouraged to consider the use of the models to track the students and provide necessary interventions to those who are likely to perform poorly in their courses. The model can also be considered in crafting amendments to the admission and retention policy of the said college.

Keywords: *students' academic performance, enrolment data, predictors, predictive model, multiple linear regression analysis*

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1. Introduction

1.1. Background of the Study

Predicting outcomes is the ability to forecast what will happen next based on the clues and data that are available. Prediction by using statistical modeling is a powerful tool for developing and testing theories by causal explanation and description. Making predictions helps in bridging connections between the new and the old or the outcomes of what supposed might happen based on the past.

Student performance prediction is essential to be conducted for an educational institution to prevent student failure. The number of student drops out is one of the parameters that can be used to measure student performance and one important point that must be evaluated for institutional accreditation. Hence, Educational institutions need to come up with proper tools to monitor and assess the performance and progress of the students (Khasanah & Harwati, 2013) [1].

In the current context, the quality and sustainability of the educational process as gauged from the performance do not depend only on the good presence of the professors and the assessment method, but also on the way the students are guided, advised, and directed in their basic education classes towards entering the college. The institution becomes a bridge between students and the labor market, thus, what is the performance indicator which makes them maintain preferable and good academic performance to be apt to success.

With the rise of big data, Educational Data Mining has become the major trend in improving the quality of education. The principle is to predict the student's academic performance at an early stage and thus provide them with timely assistance. Measuring the academic performance of students is challenging since this hinges on diverse factors like personal, socio-economic, psychological, and other environmental variables. Thus, this paper supposes to predict student performance and identify the factors that influence the academic performance of the students.

One of the state colleges in the Cordillera Administrative Region envisions becoming a preferred university of developmental culture and inclusive growth with a mission of producing globally competitive leaders molded from a tradition of excellence in instruction, research, effective governance, sustainable entrepreneurship, and an environment that assumes major responsibility in cultural vitality and well-being of the community. With this, the study resides on the premise of providing the institution with a model to share in providing quality education and services. It provides a deep investigation on predicting the performance of the students and could be considered a great concern to the higher education management in attaining its vision. This will help the educational institutions to identify the students who are at risk of failing and dropping out and therefore provide timely and functional interventions for the identified students. Furthermore, the prediction of students' performance helps the institution administrators and stakeholders design programs and projects related to leveling the students' academic status.

Using a model to predict the student's performance in finishing their course on time will help the institution answer the elusive question of whether the student will successfully finish his/her degree on time since academic performance is the main concern of the academic institution. This will give a picture of what is known to the students and provide a picture of what comes ahead in their academic performance. With this, a statistical model is needed to be designed, devised, and evaluated that could be useful to efficiently and effectively predict the students' academic performance.

HEIs that "demonstrate very good institutional quality and enhancement consistent through internal QA systems, ISO, and ISA, and demonstrate very good program outcomes through a good proportion of accredited programs, the presence of Centers of Excellence and/or Development. In particular, they show evidence of very good performance consistent with their board program passing rates. Thus, the study focus on programs with board examinations, in particular, that would consider improving board performances by predicting students' academic performance before admission. Also, consider admission policy to be incorporated to sustain quality and be globally competitive in the delivery of instruction.

Academic Performance: Academic success means that a student has satisfied the requirements for his course of study, and more goes into doing well in college than just concentrating on grades. According to Naillon [2] academic factors account for 68% of success in school; however, other things influence a person's academic success as well. Students who are fully prepared for their upcoming tasks and who tap into the resources in their environment stand the best chance of doing well in college.

Academic performance is the main indicator of cognitive enrichment, attitude, skills, abilities, and strategies with which students deal with the process to study. Although it is not the only sign of students' achievement, grades in diverse subjects are the most frequently employed operational measures. Bell [3] stated that tracking academic performance fulfills several purposes. Areas of achievement and failure in a student's

school career need to be evaluated to foster improvement and make full use of the learning process. Results provide a framework when talking about how students fare in school and a constant standard to which all students are held.

Academic Performance Predictors: Students' academic gain and learning performances are affected by numerous factors including gender, age, teaching faculty, students schooling, parents/guardians' social economic status, residential area of students, medium of instruction in schools, tuition trend, daily study hours, and accommodation as hosteliaries or day scholar. Many researchers conducted detailed studies about the factors contributing to student performance at different study levels. Higher education performance is dependent upon the academic performance of graduate students. Ali *et al.* [4], observed that the measurement of students' previous educational outcomes is the most important indicator of students' future achievement. This refers to the higher the previous appearance is, the better the student's academic performance in future endeavors.

School ability is meant to reflect the purposes for which the test is most suitable. This is to assess examinees' ability to cope with school learning tasks; suggest possible placement for school learning functions; and, evaluate their achievement concerning the talents they bring to school learning situations. The Otis-Lennon School Ability Test (OLSAT), the 8th edition, is designed to measure the verbal, quantitative, and figural reasoning skills that are most closely related to scholastic achievement. This is a complex test since it assesses ability and performance on such tasks as detecting similarities and differences, solving analogies and matrices, classifying, and determining sequence. Verbal ability covers verbal comprehension specifically on antonyms, sentence completion, sentence arrangement, verbal reasoning, arithmetic reasoning, logical selection, word/letter matrix, verbal analogies, verbal classification, and inference. Meanwhile, non-verbal ability covers figural reasoning, figural analogies, pattern matrix, figural series, quantitative reasoning, number series, numeric inference, and number matrix.

Komaraju *et al.* (2013) state that identifying the best predictors of academic performance is crucial for post-secondary institutions seeking students with the greatest promise. The relative strength of Standardized Test Scores (ACT), high school GPA, and non-cognitive college readiness skills in predicting college GPA. Results showed that students in groups with higher high school grade point average (GPA) or lower ACT reported an increased college readiness. Specifically, students with higher ACT scores are not necessarily well prepared for college. Students with higher high school GPAs have the psychosocial skills for college success. 26% of the variance in college GPA is explained by ACT scores, high school GPA, and academic discipline. Academic discipline mediates the relationship between high school GPA and college GPA. It is then presupposed that the use of post-secondary institutions can identify "at-risk" college freshmen and provide assistance.

Bonquin *et al.* [5] believe that senior high school serves as the preparatory level for students before stepping into college. It is consisted of various subjects according to

their chosen strand that is under different tracks. This program develops students through the method of using a higher level of teaching, broader lessons, and actual application of learning in real life. Some of the subjects were extracted from college-level courses and this serves as an introductory phase for them to be prepared. Students under Academic Strands such as Science, Technology, Engineering and Mathematics (STEM), Accountancy and Business Management (ABM), and Humanities and Social Sciences (HUMSS) are the ones who mainly receive these subjects that were subdivided into the core, applied, contextualized and specialized. The given subjects mainly focus on broad reading, writing, memorizing, reporting, and then application. Every strand has its unique academic specialization, they differ in the major subjects offered, this is classified as "specialized", and specialized subjects are the ones that will guide and lead the students to their chosen course in college.

Samuel [6] stated that the student's age and gender affect their performance and their college entrance examination (CEE) performance is the most important predictor of their academic performance. It also stated that numerical skills, reading/comprehension skills, and gender were good predictors of academic performance.

Asif *et al.* [7] stated that universities gather large volumes of data regarding their students in electronic form. The advances in the data mining field make it possible to mine these educational data and find information that allows innovative ways of supporting both teachers and students. In doing so, it helps universities not only to focus more on bright students but also to initially identify students with low academic achievement and find ways to support them. Also, Asif states that it is possible to predict the graduation performance in the 4th year at university using only pre-university marks and marks during the 1st and 2nd year courses, socioeconomic or demographic features, with reasonable accuracy. Furthermore, courses that are indicators of particularly good or poor performance have been identified.

With the rise of changing environment in tertiary education, a lot of factors were identified that could affect the academic performance of the students. With this, increasing student retention or persistence is a long-term goal in academic institutions. The consequences of student attrition are significant for students as well as for the academic and administrative staff. The importance of this issue for students is obvious-school leavers are more likely to earn less than those who graduated [8].

Since one of the likely considerations of government funding in the tertiary education environment is the retention rate, both academic and administrative staff are under pressure to come up with strategies that could increase retention rates on their courses and programs. This paper deploys the theory and practice of data mining as it relates to student performance and monitoring degree programs in the college. Such that the dependent variable considered in generating the model is the academic performance (above average, average, below average, and poor) of the first-year students in a given period.

The independent variables are the student's sex, enrolled course, senior high school GWA, strand, type of school, and Admission ability test performance. The

independent variables are considered to affect students' academic performance.

1.1. Conceptual Framework

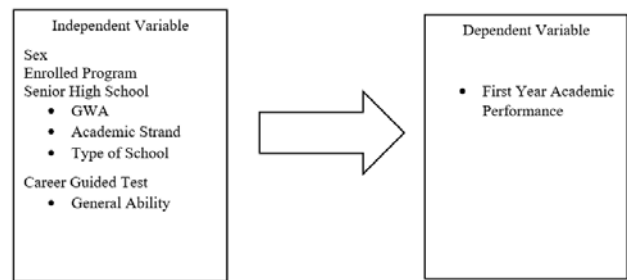


Figure 1. The paradigm of the study

1.2. Statement of the Problem

This study aims to predict Students' academic performance using multiple linear regression (MLR). Specifically, it sought to answer the following questions:

1. What is the level of students' Academic Performance according to enrollment data?
2. What are the significant predictors of students' academic performance?
3. What model can be derived to predict the student's academic performance based on enrollment data?

2. Design and Methodology

The correlational research design was employed in this study to explore the relationships between students' sex, course enrolled, senior high school data and college career-guided test performance of the first-year students enrolled. A statistical model for predicting students' academic performance as a dependent variable based on students' sex, course enrolled, senior high school data, and college career-guided test performance was established.

The study was conducted in one of the State Universities and Colleges (SUCs) in Cordillera Administrative Region (CAR). The population of the study were the first-year students enrolled during the school year 2019-2020, the first semester, and completed up to the second semester. The data include 596 students who are enrolled in the different programs with board exams offered in the college. The data gathered were the students' sex, the program enrolled, senior high GWA, strand, type of school, career-guided test performance, and first-year academic performance.

To facilitate the gathering of data, students' data such as sex, and career-guided test performance was taken at the Student Services and Development Office (SSDO), MPSPC upon approval of the request. Also the senior high GWA, strand, type of school, course enrolled and the general weighted average (GWA) of the first year for the two semesters for SY 2019-2020 was obtained at the office of the registrar upon approval of the request by the Admissions and Registrars' Office Director. Before the gathering of data, the signing of consent was administered to students who were covered in the study to ask permission that their records to be considered for research purposes only.

For this study, the data were collected from the College database and was replaced with dummy codes to replace the original names and registration number. The dataset collected may be messy and inconsistent, hence not fitting for data analysis. Data cleaning was performed to replace and correct the records and remove data which are not needed in the analysis. The cleaned data were subjected to appropriate statistical analysis to answer the identified problems of the study using MLR with the aid of the Statistical Product and Service Solutions (SPSS) software.

Stepwise Multiple Linear Regression (MLR), is a statistical technique that uses several explanatory variables to predict the outcome of a response variable. The goal of multiple linear regression is to model the linear relationship between the explanatory (independent) variables and response (dependent) variables. In essence, multiple regression is the extension of ordinary least-squares (OLS) regression because it involves more than one explanatory variable.

3. Results and Discussion

This chapter presents the analyses, presentation, and interpretation of the data of the study. It also includes implications of the results and corroborations with other studies if there are any.

3.1. Students' Academic Performance in their First Year of Study

To gain a better understanding of the overall picture of students enrolled in the different programs as well as part of the data understanding phase, the data were cross-tabulated according to the program enrolled and performance in college admission test by academic performance.

Before the modeling, variables were summarized by categories and by study outcome in the given academic period. The academic period is the first, and the second semester of the school year, and the study outcomes are the average of the first and second-semester performance. The academic performances of students were classified into 4 such above average, average, below average, and poor. Students who were labeled above average are students with a general weighted average of 89.5% and above, average are students with a general weighted average of 84.5% to 89.4%. Also, below average are students with a general weighted average of 79.5% to 84.4%. Lastly, are labeled poor were those who got a general weighted average grade equivalent to below 79.4% and below. First-year students, who are transferees and shifters from other programs were excluded from the analysis.

Table 1.1. Distribution of first-year academic performance according to students' sex

Sex	N	Mean Performance	DE
Male	303	81.66%	Below Average
Female	293	85.27%	Average
Total	596	83.43%	Below Average

Table 1.1 depicts the gender distribution of students' academic performance. As revealed, nearly equal numbers of males and females exist. Furthermore, it was discovered that the students' overall performance is below average. Males perform below average, while females perform average.

Table 1.2. Distribution of first-year academic performance according to students' course

Course	N	Mean Performance	DE
BSCrim	331	82.31%	Below Average
BSED	99	85.88%	Average
BEED	61	83.92%	Below Average
BSN	63	83.19%	Below Average
BSA	42	86.12%	Average
Over-All	596	83.43%	Below Average

Table 1.2 displays the performance of students in their first year of study by course. According to the frequency distribution, the majority of students are from the Bachelor of Criminology (BSCrim), followed by the Bachelor of Secondary Education (BSED), Bachelor of Science in Nursing (BSN), Bachelor of Elementary Education (BEED), and Bachelor of Science in Accountancy (BSA).

Furthermore, the students' overall academic performance is below average, with a mean of 83.43%. Specifically, BSED and BSA students achieve an average of 85.88% and 86.12%, respectively. Students in the BSCrim, BEED, and BSN programs perform below average, with an average performance of 82.31%, 83.92%, and 83.19%, respectively. Students perform differently, implying that the course differs in terms of the level of difficulty of the content, classroom environment, and even instructors' pedagogies in teaching during the first year curriculum that was offered. As a result, students who receive high grades should be satisfied with their academic programs as a result of their wise decision to enroll in the program.

Table 1.3. Distribution of first-year academic performance according to students' high school strand

High School Strand	N	Mean Performance	DE
STEM	71	87.17%	Average
HUMSS	114	85.36%	Average
GAS	117	82.96%	Below Average
TVL	163	83.54%	Below Average
ABM	42	86.29%	Average
ALS & BEC	89	77.05%	Poor
Total	596	83.43%	Below Average

The distribution of first-year academic performance by high school strand is shown in the table. Students from STEM, HUMSS, and ABM performed on average, with mean scores of 87.17%, 85.36%, and 86.29%, respectively. Furthermore, students from the GAS and TVL strands perform below average, with mean scores of 82.96% and 83.54%, respectively. Finally, ALS and BEC students perform poorly in their first year of study.

The senior high program plays an important role and function in preparing students for college, including assessments that shape their skills and talents, training that

prepares them for the international workplace, and programs that can provide them with standard quality education. With the Senior High School's positive roles, functions, impact, and benefits, many students considered the program's positive effects not only on them, but also on the teachers and family members who are also beneficiaries of the new educational system [5].

Table 1.4. Distribution of first-year academic performance according to students' type of school graduated

Type of School	N	Mean Performance	DE
Private	127	83.39%	Below Average
Public	469	83.44%	Below Average
Total	596	83.43%	Below Average

Table 1.4 depicts the distribution of first-year academic performance based on the type of school from which students graduated. It was discovered that the vast majority of students are graduates of public schools. Furthermore, students from private and public schools perform below average, with mean performance of 83.39% and 83.44%, respectively.

3.2. Variables Influencing Academic Performance of First-Year Students

To gain a better understanding of the overall picture of students enrolled in the different programs as well as part of the data understanding phase, the data (admission data) were correlated to academic performance.

Table 2 shows the variables that influence academic performance. As a starting point, feature selection was used.

Pre-processor for predictive data mining that organizes predictors based on the strength of their relationship to the dependent variable, which is student academic performance. The result of the feature selection was that the list of variables was arranged in order of importance based on their correlation coefficient value. The stronger their relationship, the more evidence that a specific predictor is important to the model. It demonstrates that the majority of the predictors are statistically significant, as evidenced by probability values less than 0.01. The features are listed in decreasing order of importance to academic performance, from most important to least important.

In the study's findings for first-year academic performance. As a result, the list of variables influencing students' academic performance is quite resistant to changes in the academic performance definition.

It was discovered that the Admission test is the most variable associated with students' academic performance as the general ability of the students in their admission test, implying that the admission test plays a significant role in determining the performance of the students in college, followed by the high school General Weighted Average (GWA), implying that high school GWA are measured similarly in college. Such findings corroborate the finding of Padawil, *et al.*, [9] who stated that high school average grade correlates with the college academic performance, clinical performance, and general weighted average of the students. And they suggested that high school average grades should be considered upon admission of freshmen

student nurses. This is followed by the strand, sex, and course of students. On the other hand, it was noted that the type of school is not associated with students' academic performance since the relationship is not significant.

Table 2. Influential Factors to Academic Performances of Students

Predictors	Coefficient of Correlation r	P-Value
General Ability	.767**	0.000
HS GWA	.728**	0.000
HS Strand	-.425**	0.000
Sex	.321**	0.000
Course	.161**	0.000
Type of School	.004 ^{NS}	0.930

Legend: ^{NS} Not Significant
 ** Highly Significant

This implies that whether a student is a graduate of public or private schools performed the same in their first year of study. In addition, this tells that public and private schools offer the same curriculum which helps and prepares the students for their college endeavors. Further study reveals that failure in college does not have a relationship with the type of school graduated from [9]. This suggests then now the exclusion in the analysis where this factor does not have a bearing on the academic performance of the students.

Lastly, it was noted that the course has the least association variable with students' academic performance having the lowest coefficient of correlation value as compared to the other variables. However, it is suggested that even though some variables may have little significant association, they can be essential to a specific record in the given data set. Thus, all significant available variables are included in the analysis.

3.3. Model of Students' Academic Performance: Using Stepwise Multiple Linear Regression Model

Stepwise Multiple Linear Regression is used to model the relationship between a continuous response variable and continuous or categorical explanatory variables. As the academic performance of the students is the response variable and the enrolment data would be the explanatory variable.

Validation and Evaluation of MLR Model: MLR is used to predict the value of the dependent variable according to the independent variable. For selecting independent variables, the causal relationship between the independent variables was considered. And to evaluate the goodness of fit of the model the R² was used.

The adjusted R² or the coefficient of determination is the proportion of variance in the dependent variable (academic performance) which can be predicted from the independent variables (admission ability, HS GWA, Sex, and Course) is 67.3%. This value indicates that the variance in academic performance can be predicted from the variables admission ability, HS GWA, Sex, and Course. Considering that this is an overall measure of the strength of association, and does not reflect the extent to which any particular independent variable is associated with the dependent variable.

The regression model based on the ANOVA table was found significant with F value=307.644, p value=.000 which implies that the group of independent variables does show a statistically significant relationship with the dependent variable, or that the group of independent variables does reliably predict the dependent variable. Taking note that this is an overall significance assessing whether the group of independent variables when used together reliably predicts the dependent variable, and does not address the ability of any of the particular independent variables to predict the dependent variable. The ability of each independent variable to predict the dependent variable is addressed in the table below where each of the individual variables is listed.

Therefore the group of variables as admission ability, HS GWA, Sex, and Course can be used to reliably predict the academic performance of the students as the dependent variable. The regression shows the values for the regression equation for predicting the academic performance (dependent variable) from the enrolment data (independent variable). As such, the coefficients cannot be compared with one another to determine which one is more influential in the model, because they can be measured on different scales. Given the Regression model as;

$$Y_{Predicted} = b_0 + b_1 * x_1 + b_2 * x_2 + b_3 * x_3 + b_4 * x_4$$

$$Y = 37.088 + (0.406)GW + (0.399)GA \\ + (0.935)S - (0.241)C$$

Whereas;

Y – Performance

GW - GWA

GA - Gen Ability

S - Sex

C – Course

These estimates tell about the relationship between the independent variables and the dependent variable. These estimates tell the amount of increase in academic performance that would be predicted by a 1 unit increase in the predictor. Note: For the independent variables which are not significant, the coefficients are not significantly different from 0, which should be taken into account when interpreting the coefficients.

The model tells now that for every 1 unit increase in General ability, then the academic performance would increase by .399 considering other variables held constant. And, for every 1 unit increase in GWA, then the academic performance would increase by .406 considering other variables held constant. Also for every 1 unit increase in sex, then the academic performance would increase by .935 considering other variables held constant. Lastly, for every 1 unit increase in the course, then the academic performance would decrease by -.241 considering other variables held constant.

More generally, if a student was to increase the high school GWA, and general ability and students are from the senior high school academic strand then it is expected to be more likely to improve or increase academic performance. This implies that students' academic history performance in high school and admission ability test is associated with their college academic performance. Such findings corroborate the finding of Padawil *et al.* [9] who

stated that high school average grade correlates with college academic performance. Samuel [6] states that the entrance examination, numerical skills, and gender of the students are significant predictors of students' academic performance in college. Also, Calaguas [10] stated that students' academic performance and their general academic aptitude are positively highly correlated and that is true for all students.

In summary: The salient findings of the study are the following. The student's academic performance is classified to be below average performance. The variables as factors that are associated with the academic performance of the students were the admission ability, high school GWA, sex, and course. The academic performance of first-year students can be predicted using the MLR model considering admission ability, high school GWA, sex, and course of the students as predictors. The derived model for predicting the academic performance of the students has good predictive power. This would entail considerable variables as predictors to be incorporated in the model since it is noted that there are many factors influencing students' academic performance for improvement of the model accuracy in prediction.

4. Conclusions

The decision model is generated to be used to predict undergraduate students' academic performance. Based on the findings, the following are concluded;

1. The academic performance of the students is highly associated with their high school GWA, admission ability, course, and sex.
2. The academic performance of first-year students can be predicted using the MLR model considering admission ability, high school GWA, sex, and course of the students as predictors.
3. The derived model for predicting the academic performance of the students has a predictive power of 67.3% derived model is found to be a good model.

Statement of Competing Interest

The author have no competing interests.

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