

# MATHEMATICS PROFICIENCY OF STUDENTS ENROLLED IN PHYSICS 101: PREDICTOR TO THEIR PERFORMANCE

Raquel D. Quiambao

**Abstract**— Predicting the performance of students in a course based on their performance on certain examinations previously, as well as other alternative variables, taken is not an easy task. Educational institutions intending to undergo such a rigorous endeavor would eventually find it necessary to develop a regression model by identifying a set of probable predictors. This study attempted to determine the predictive ability of students' Mathematics Proficiency as predictor of their performance in Physics 101. Moreover, the predictive ability of the following variables – sex, IQ, College Admission Test(CAT)-Numerical Ability, and CAT-Verbal Ability – was also scrutinized. In view of the foregoing research thrust, this study looked into the profile of the respondents in the following set of predictors: Mathematics Proficiency, sex, IQ, CAT-Numerical Ability, and CAT-Verbal Ability; and identify which among these are predictive of their performance in Physics 101. The respondents of the study included the students in Don Mariano Marcos Memorial State University – South La Union Campus, Agoo, La Union who were enrolled in Physics 101 during the school year 2015-2016. Results indicate that the males are outnumbered by a ratio of 2:1. Using multiple regression analysis, the students' Mathematics Proficiency, Numerical Ability, and Verbal Ability are significantly correlated with and are modest predictors of performance in Physics 101. Sex does not give a rough indication of Physics performance. Moreover, Mathematics Proficiency manifests to be the preeminent predictor of performance in Physics.

**Index Terms**— mathematics proficiency, Physics 101, predictor, performance, skewness, kurtosis, numerical ability, verbal ability

## 1 INTRODUCTION

Predicting the performance of a student in a course based on the performance in the essential tools is no easy task. Developing such a regression model would be useful to any educational institution as the identification of a set of predictors may employ a variety of uses. First, predictors may be employed to direct students in the choice of subjects that they undertake for their studies. They may be used to identify students who may have difficulties in making the grade ahead on such that remedial action may be instituted. Good predictive criteria may also be used to point out the 'gifted' such that they may be given challenges to their learning.

Physics is a science wherein quantities measured experimentally by direct or indirect means are to be communicated. Mathematics is used for such communication. Equations tell how concepts are related to one another. New statements and relationships in Physics are derived using the rules of Mathematics. Lord Kelvin, one of the founders of the science of thermodynamics, said that in physical science one knows what he is talking about only when he can measure and express it in numbers (Abastillas et al., 1994).

Casual observations of students' performance by the researcher in her 15 years of teaching Physics suggested that a good number of Physics students were not doing as well as one would desire. This trend is evidenced by the low performance in quizzes and periodical tests that she and other Physics professors set their students

and by the considerable proportion of students that have to re-enroll the subject due to failure. More often than not, students lack the necessary mathematical concepts and principles as well as the skills to solve Physics problems using mathematical concepts or skills. Failure to acquire said skills will most likely rebound to failure in science subjects, particularly Physics.

Attempts must therefore be done to institute remedial measures to address the problems encountered. Cognizant to this need, this study focused on the mathematics proficiency of the students enrolled in Physics and looked into this mathematical proficiency and other variables as predictors to their performance in Physics.

This study determined the mathematics proficiency of the students enrolled in Physics 101 and looked into this as predictor to their performance. Specifically, this study answered the following questions:

1. What is the profile of the students in terms of  
a. sex b. Numerical Ability c. Verbal Ability  
d. Intelligence Quotient (IQ) e. Mathematics proficiency  
f. Performance in Physics?
2. How valid are the mathematics proficiency and the other factors as predictors of performance in Physics?
3. Which of the above factors is the best predictor of performance in Physics?

## 2 METHODOLOGY

The descriptive research design was employed in this study because of the nature of the data of interest that were gathered without any manipulation on the part of the researcher to influence the outcome of the study.

The respondents of the study are the students of Don Mariano Marcos Memorial state University-South La Union Campus, Agoo, La Union enrolled in Physics 1 for the school year 2015-2016. Total enumeration was employed and the study involved 137 students.

The main instrument in gathering the needed data was the 40-item Mathematics Proficiency Test which the researcher constructed herself. The test covered areas in Mathematics that are useful in Physics which included Basic Mathematics, Algebra, Plane Trigonometry and Solid Geometry. The test was validated to students enrolled in Physics 1 in DMMMSU-Mid La Union Campus who were not respondents of this study. The reliability coefficient of the test was 0.87 which was obtained using Kuder-Richardson Formula 20.

Other data which included Numerical Ability, Verbal Ability and IQ were lifted from the College Admission Test(CAT) Results which were taken from the Office of Student Affairs(SAS).

Percentage was used in presenting the profile of the students in terms of sex and the skills of the students in Mathematics. The mean, standard deviation, skewness, and kurtosis were used to describe the profile of the respondents in Numerical ability, Verbal Ability, IQ, and Mathematics proficiency. Multiple Regression Analysis was employed to determine how valid the factors are as predictors of performance in Physics. Statistical Package for Social Sciences (SPSS) Version 21 was used to process gathered data.

## 3 RESULTS AND DISCUSSION

Of the 137 respondents, 84 are female and 53 are male. Males are outnumbered by a ratio close to 2:1

The profile of the respondents in terms of Numerical Ability, Verbal Ability and Intelligence Quotient (IQ) is displayed in Table 1.

Table 1. Numerical Ability, Verbal Ability and IQ of the respondents.

| Statistics         | Numerical Ability<br>(50 items) | Verbal Ability<br>(80 items) | Intelligence Quotient |
|--------------------|---------------------------------|------------------------------|-----------------------|
| Highest Score      | 42                              | 67                           | 125                   |
| Lowest Score       | 10                              | 5                            | 71                    |
| Mean               | 23.88                           | 43.97                        | 84.23                 |
| Standard Deviation | 6.98                            | 10.12                        | 18.24                 |

|                    |        |        |        |
|--------------------|--------|--------|--------|
| Skewness           | 0.393  | -0.078 | -0.088 |
| Kurtosis           | -0.313 | 1.296  | -0.659 |
| No. of Respondents | 137    | 137    | 137    |

The table reveals that the respondents had a mean numerical ability scores of 23.88 with a standard deviation of 6.98. This implies that most of the respondent's numerical ability scores ranged within  $23.88 \pm 6.98$ , that is approximately from 17 – 31. The skewness of 0.393 indicates that the distribution is slightly skewed to the left. This means that majority of the scores massed at the right side of the curve and the rest of the scores gradually spread to the left. It implies that there were more students whose scores were above the mean of 23.88 than those below the mean in terms of numerical ability. The kurtosis of -0.313 showed that the distribution is platykurtic, which means that the numerical ability scores are more widely distributed about the mean than in a normal distribution.

It can also be gleaned from the table that the respondents had a mean verbal ability score of 43.97 with a standard deviation of 10.12. This indicates that most of the respondents' verbal ability scores ranged within  $43.97 \pm 10.12$ , that is, from 34-54, suggestive of 'fair' to 'good' verbal ability.

The table also exhibits the respondents' mean IQ of 84.23 with a standard deviation of 18.24. This shows that most of the respondents' IQ ranged within  $84.23 \pm 18.24$ , values from 66-102, representing below average to above average. The skewness of -0.088 indicates that there were more students whose IQ were above than below the mean. The kurtosis of -0.659 showed that the distribution is platykurtic, which means that the scores are more widely distributed about the mean than in normal distribution.

### Mathematics Proficiency of the Respondents

The descriptive statistics of the Mathematics Proficiency of the respondents are shown in Table 2.

Table 2 Mathematics Proficiency of the respondents

| Statistics         | Mathematics Proficiency Test |
|--------------------|------------------------------|
| Highest Score      | 35                           |
| Lowest Score       | 8                            |
| Mean               | 15.73                        |
| Standard Deviation | 8.604                        |
| Skewness           | 0.648                        |
| Kurtosis           | -0.524                       |
| N                  | 137                          |

The respondents' Mathematics Proficiency had a mean of 13.73 with a standard deviation of 8.604. It indicates the performances are varied. Hence, the relative heterogeneity of the respondents in terms of mathematics proficiency. The kurtosis is negative which is platykurtic. It shows variation of scores about the mean and further verifies that the respondents were heterogeneous. It also

shows that the scores are scattered about the mean. The positive result of skewness explains further that most of the scores were found above the mean.

### Performance in Physics

The descriptive statistics of the Performance in Physics of the respondents in terms of their final grades are exhibited in the following table.

Table 3. Performance in Physics of the respondents.

| Statistics         | Mathematics Proficiency Test |
|--------------------|------------------------------|
| Highest Grade      | 93                           |
| Lowest Grade       | 70                           |
| Mean               | 78.18                        |
| Standard Deviation | 4.56                         |
| Skewness           | 1.04                         |
| Kurtosis           | .82                          |
| N                  | 137                          |

It indicates the performances are varied. Hence, the relative heterogeneity of the respondents in terms of performance in Physics. The kurtosis is positive which shows variation of scores about the mean and further verifies that the respondents were heterogeneous. It also shows that the scores are scattered about the mean. The positive result of skewness explains further that most of the scores were found above the mean.

The respondents' Performance in Physics as indicated by their grades in the subject had a mean of 78.18 with with a standard deviation of 4.56.

### Correlation and Multiple Regression Analysis

Table 4 summarizes the analysis results on correlation and multiple regression analyses were conducted to examine the relationship between performance in Physics 101 and various potential predictors. As can be seen each of the variables Mathematics Proficiency, Numerical ability, Verbal Ability, and Intelligence Quotient (IQ) is positively and significantly correlated with Performance in Physics, indicating that those with higher scores on these variables tend to have higher or better performance in Physics.

Sex is negatively correlated with performance in Physics (coded as 1= male, 2 female), indicating that the males tend to have higher or better performance in Physics, although it is not significant.

Table 4 Correlations and results from the regression analysis

| Variables                  | Correlation with Performance in Physics | Unstandardized coefficients |                | t       | p-value |
|----------------------------|---|-----------------------------|----------------|---------|---------|
|                            |   | B                           | Standard error |         |         |
| (Constant)                 |   | 68.316                      | .637           | 107.205 | .000    |
| Sex <sup>^</sup>           | -.029                                   | -.078                       | .231           | -.336   | .737    |
| Mathematics Proficiency    | .734**                                  | .336                        | .027           | 12.382  | .000    |
| Numerical Ability          | .361**                                  | .104                        | .023           | 4.425   | .000    |
| Verbal Ability             | .259**                                  | .061                        | .020           | 3.074   | .003    |
| Intelligence Quotient (IQ) | .176*                                   | .015                        | .007           | 2.046   | .043    |

<sup>^</sup>coded as 1= male, 2=female  
 \*p < .05    \*\*p < .01

The multiple regression model with all four variables produced  $R^2 = .921$ ,  $F(5,136)=305.316$ ,  $p < .01$ . The  $R^2$  of .921 suggests that 92% of the variation in Performance in Physics can be explained by its relationships with the predictor variables: Mathematics Proficiency, Numerical ability, Verbal Ability, and Intelligence Quotient (IQ). Only

8% of the variation in Performance in Physics is said to be residual and this could be due to error and other factors not investigated. The F-ratio (5,136) of 305.316( $p < .01$ ) implies that there is a significant relationship between Performance in Physics and the four predictor variables taken together. As can be seen in Table 5, the Mathematics Proficiency, Numerical Ability, Verbal Ability, and IQ had signifi-

cant positive regression weights, indicating students with higher scores on these variables were expected to have higher or better performance in Physics, after controlling for the other variables in the model.

Based on the results of the analysis, a regression model to compute predicted Performance in Physics is given as follows:

$$\begin{aligned} \text{Predicted Performance in Physics} \\ = 68.316 + .336*\text{Math Prof} + .104*\text{Num Ability} \\ + .061*\text{Verbal Ability} + .015*IQ \end{aligned}$$

Table 4 reveals that the partial correlation coefficients B for Mathematics Proficiency, Numerical Ability, Verbal Ability, and Intelligence Quotient (IQ) have t-values ( $p < .05$ ) which are significant at  $\alpha = .05$ . However, sex has a t value ( $p > 0.05$ ) which is not significant at  $\alpha = 0.05$ . Thus, sex was not entered into the equation for the predicted performance in physics. The regression model tells that the Performance in Physics is predicted to increase by .336 when Mathematics Proficiency goes up by one, increase by .104 when Numerical Ability goes up by one, increase by .061 when Verbal Ability goes up by one, increase by .015 when IQ goes up by one and is predicted to be 68.316 when all the four predictors are zero. This further implies that 68.316 % of the performance in Physics can be explained by other variables not covered in the study. Sex does not contribute to the multiple regression model.

Furthermore, Mathematics Proficiency which accounts 33.6% of the variation in the Performance in Physics is the best predictor among the considered factors.

## 4 CONCLUSION

Males are outnumbered with a ratio close to 2:1. The numerical ability of the students ranged from good to satisfactory ; verbal ability from satisfactory to very satisfactory; IQ from below to above average, Mathematics proficiency from failing to average; and Performance in Physics from fair to good.

Each of the variables Mathematics Proficiency, Numerical ability, Verbal Ability, and Intelligence Quotient (IQ) is positively and significantly correlated with Performance in Physics, indicating that those with higher scores on these variables tend to have higher or better performance in Physics. Sex is negatively correlated with performance in Physics (coded as 1= male, 2 female), indicating that the males tend to have higher or better performance in Physics. However, no statistically significant linear dependence of the mean of performance in Physics on sex was detected.

Mathematics Proficiency is the best predictor of Performance in Physics.

## 5 RECOMMENDATION

The Mathematics proficiency of the students should be used to diagnose those who may have difficulties in making the grade in Physics ahead on such that remedial action may be instituted and to point out the 'gifted' such that they may be given challenges to their learning.

A remedial program should be instituted to address the problem on the students' deficiencies in Mathematics skills useful in Physics in as much as failure to acquire said skills will most likely redound to failure in Physics.

This area requires further study considering other potential variables like grade-point average (GPA) in high school and high school grades in Physics and Mathematics should be undertaken to identify other valid factors that are responsible for the variation in Performance in Physics that were unaccounted by this set of predictors.

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