Modelling Students' Performance in Plane Trigonometry with their Levels of Intrinsic And Extrinsic Motivations

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Abstract

The nature of motivation is vital for the improvement of student learning outcomes. Exploring the motivational beliefs as to intrinsic and extrinsic motivation is a critical way to understand the impact of these two types of motivation as driving behavior in learning plane trigonometry subject among college students. The study aimed to generate a model of the students' academic performance in mathematics using their intrinsic and extrinsic motivation. The study used a correlational research design, which consisted of 140 responses from selected college students of Agusan del Sur State College of Agriculture and Technology. Further, the students enrolled in a Plane Trigonometry subject during the 1st semester of A.Y. 2015-2016 were selected through a random sampling technique. To determine the intrinsic and extrinsic motivation in learning mathematics, respondents were evaluated based on a modified checklist from the Academic Motivation Scale (AMS–C 28) College version of Vallerand et al. (1993). Results revealed that intrinsic and extrinsic motivation had a significant impact on the students' academic performance in mathematics. Thus, the students are intrinsically and extrinsically motivated to ensure a good grade in mathematics.

Keywords*: Academic Performance, Intrinsic Motivation, Extrinsic Motivation, Multiple Linear Regression Model, Plane Trigonometrys*

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1.0 Introduction

Mathematics is a systematic application of matter that affects all aspects of human life at different levels. Certain qualities nurtured by mathematics are the power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability, and even practical communication skills. It is a realization of the vast applications of mathematics that made Eraikhuemen (2003) posit that a disciplined and ordered pattern of life can only be achieved through the culture of mathematics. Unfortunately, students' academic performance in this vital subject has persistently been reduced over the years. Studies revealed that academic achievement is greatly affected by the students' motivation intrinsically and extrinsically (Adesemowo, 2005; Kusurkar, Ten Cate, Vos, Westers, & Croiset, 2013). Motivation has been shown to positively impact academic performance, adjustment, study strategy, and well-being in students in domains of education (Vansteenkiste, Zhou, Lens, & Soenens, 2005). Hence, the study was conducted to generate a model of the students' academic performance in mathematics using their intrinsic and extrinsic motivation.

Academic performance is affected by some factors, including admission grade (Hoefer & Gould, 2000; Kuncel, Credé & Thomas, 2007), social (Lievens, Coetsier, De Fruyt, & De Maeseneer, 2002; Poropat, 2009), economic status (Considine & Zappalà, 2002; Barry, 2006; Kyoshaba, 2009), school background (MacNeil, Prater, & Busch, 2009; Reyes, Brackett, Rivers, White, & Salovey, 2012), and much more. However, this study focused on the students' intrinsic and extrinsic motivation in learning mathematics factors. Awanbor (2005) suggested that students should be academically motivated. This will go a long way to solving most of the problems faced in the education system and also increase students' academic performance. According to Dev (1997), students' academic success is best geared from intrinsic motivation. Most educators would suggest that intrinsic motivation is best (Walker, Greene, & Mansell, 2006; Deci & Ryan, 2010; Schneider, 2012); it is not always possible in every situation. This is especially the case after early childhood, when the freedom to be intrinsically motivated becomes increasingly curtailed by social demands and roles that require individuals to assume responsibility for non inherently interesting tasks (Ryan & Deci, 2000). In other circumstances, students simply have temporal stability of the internal desire to engage in an activity (Tsigilis & Theodosiou, 2003). These students perceive themselves as in control of learning when rewards are given, they approach and complete tasks differently than when prizes are not provided, and their work is judged as less appreciated (Hoffmann, Huff, Patterson, & Nietfeld, 2009; Seitz, Kim, & Watanabe, 2009). Thus, extrinsic motivation can get students to complete a work task of the school assignment in which they have no private interest. However, excessive rewards may be problematic, which causes an overjustification effect (Carlson and Heth, 2007).

The motivational 'crowding out' is a phenomenon in which students are being rewarded for doing something right that diminishes their intrinsic motivation to perform a particular action. Its effect limits operant conditioning relative to extrinsic motivation and its effectiveness in the applied setting. However, operant conditioning should be used with caution to avoid low intrinsic motivation and evade possible cognitive consequences (Griggs, 2010). Extrinsic and intrinsic motivation are both important ways of driving students' behavior in learning mathematics. Further, to comprehend how these are best utilized, it is essential to understand the impact of these two types of motivation on the students' academic performance. In the existing literature, several studies have conflicting results on whether these motivations are significantly predicting Mathematics achievement. The studies of Lepper, Corpus, & Iyengar (2005) and Areepattamannil (2014) revealed that intrinsic motivation was a statistically significant positive predictor while extrinsic motivation was a statistically significant negative predictor of mathematics achievement. In contrast to the latter, a study conducted by Ayub (2010) showed that intrinsic and extrinsic motivation and academic performance were positively correlated. Also, examining the effect size of these motivations is insufficient as the existing studies are exhaustively investigated. The study of Güvendir (2016) showed that intrinsic motivational variables have a stronger relationship with mathematics achievement than extrinsic motivation variables. Thus, the present study was formulated to verify these reservations regarding the research gaps about the motivations in learning mathematics.

The study generated the students' academic performance model using intrinsic and extrinsic motivation through Linear Regression Analysis. Further, the created model was tested over diagnostic checking on the underlying assumptions for its robustness, including multivariate normality, the constancy of variance, absence of multicollinearity, and outlier.

2.0 Variables in the study

The study had looked into the Self-Determination Theory (SDT). It is a macro theory of human motivation and personality that concerns people's inherent growth tendencies and innate psychological needs. It is based on the quality of motivation that differentiates between intrinsic that originates within an individual and extrinsic that originates from external sources.

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Researchers have also found that the two types of motivation can differ in their effectiveness at driving behavior.

Intrinsic motivation is the natural, inherent drive to seek out challenges and new possibilities associated with cognitive and social development. Meanwhile, extrinsic motivation refers to the tendency to perform activities for known external rewards, whether this is tangible (e.g., money) or psychological (e.g., praise) in nature (Brown, 2007). This comes from external sources motivated to perform a behavior or engage in an activity to earn a reward or avoid punishment. These can increase students' academic performance (Ayub, 2010).

Intrinsic (X_1) and extrinsic (X_2) motivation as independent variables in predicting the academic performance of the students in mathematics that was obtained from their final grade in the Plane Trigonometry subject (Y) are considered in this study.

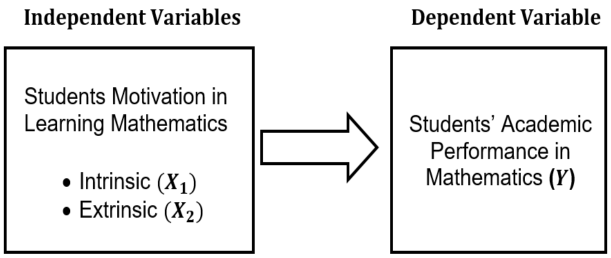

Figure 1. Conceptual Framework of the Study

3.0 Research Design and Methods

3.1 Source of Data

The study used a multiple regression analysis to identify the factors predicting students' academic performance in mathematics. The data were collected from the responses of the 140 selected college students of Agusan del Sur State College of Agriculture and Technology. They were enrolled in a Math 05 Plane Trigonometry subject. Further, the students were selected through a random sampling technique.

3.2 Research Instruments

The study used a modified checklist from the Academic Motivation Scale (AMS –C 28) College version of Vallerand, Pelletier, Blais, Briere, Senecal, & Vallieres (1993) as the research instrument. The modified checklist items indicate the level of intrinsic and extrinsic motivation of the college students in learning mathematics. The academic motivation scale is one of the most used instruments (Vallerand, Blais, Briere, & Pelletier, 1998). This is aimed at adolescents and adults in academic environments; its original French and English versions have 28 items distributed in seven subscales that respond to the dimensions referenced in self-determination theory. The seven-factor structure, postulated in the initial theoretical model from Vallerand et al. (1998), was verified by subsequent confirmatory analyses and showed adequate internal consistency. The validity was determined by two experts in measurement and evaluation and one in mathematics education. The instruments have reliability coefficients of 0.86 and 0.94, determined using the tests-retest method. The checklist was administered to the selected students and was instructed on its details. Then, the responses were gathered and subjected to analysis and further interpretation.

The Multiple Linear Regression analysis was used in generating a model of students' academic performance in mathematics using the level of their intrinsic and extrinsic motivation. Multiple Linear Regression endeavors to model the association between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with the dependent variable y. Moreover, the level of the Students' Intrinsic and Extrinsic Motivation in Learning Mathematics was determined through the benchmarks of a Likert Scale, which is shown below. Students respond to each item on a Likert-type rating scale: strongly disagree (1), disagree (2), neither disagree nor agree (3), agree (4), or strongly agree (5).

Table 1. Likert Scale of the Students' Intrinsic and Extrinsic Motivations in Learning Mathematics

Rate	Interval	Descriptive Response	Interpretation of the Level of Students' Motivation
1	1.00-1.79	Strongly Disagree	**Very Low**. Students' motivation towards learning Plane Trigonometry subject is *negligibly evident*
2	1.80-2.59	Disagree	**Low.** Students' motivation towards learning Plane Trigonometry subject is *slightly evident.*
3	2.60-3.39	Neither Disagree or Agree	**Moderate.** Students' motivation towards learning Plane Trigonometry subject is *moderately evident.*
4	3.40-4.19	Agree	**High.** Students' motivation towards learning Plane Trigonometry subject is *highly evident.*
5	4.20-5.00	Strongly Agree	**Very High.** Students' motivation towards learning Plane Trigonometry subject is *extremely evident.*

4.0 Results and Discussion

4.1.1 Level of the Students' Intrinsic Motivation in Learning Plane Trigonometry

The level of students' intrinsic motivation in learning plane trigonometry is shown in Table 2.1. It reveals that the overall rating of the students as to their intrinsic motivation is high, which constitutes a weighted mean of 3.60. This means that the students' intrinsic motivation toward learning the subject is highly evident. Moreover, an indicator of intrinsic motivation as the students are experiencing pleasure and satisfaction while learning new things obtained the lowest average of 3.22. Meanwhile, most of the students agreed that Mathematics is fun that resulted in the highest average of 3.99.

Table 2.1. Level of the Students' Intrinsic and Extrinsic Motivation in Learning Plane Trigonometry

Intrinsic Motivation	**Ave.**	**Descriptive Response**	**Level of Motivation**
1. Because I experience pleasure and satisfaction while learning new things.	3.22	Neither disgaree nor agree	Moderate
2. Because I like learning Mathematics.	3.82	Agree	High
3. For pleasure, I experience while surpassing myself in learning Mathematics.	3.46	Agree	High
4. For pleasure, I experience when I discover new things in learning Mathematics.	3.44	Agree	High
5. Because for me, learning Mathematics is fun.	3.99	Agree	High
6. For the pleasure that I experience while I am solving Mathematical problems.	3.48	Agree	High
7. For the pleasure that I experience in broadening my knowledge about Mathematics.	3.61	Agree	High
8. For the pleasure that I experience when discussions take me with exciting teachers.	3.57	Agree	High
9. For satisfaction, I feel when I am in the process of accomplishing difficult Mathematical problems.	3.59	Agree	High
10. Because Mathematics allows me to continue to learn about many things that interest me.	3.71	Agree	High
Overall Weighted Mean	**3.60**	**Agree**	**High**

4.1.2 Level of the Students' Extrinsic Motivation in Learning Plane Trigonometry

The level of students' extrinsic motivation in learning plane trigonometry is shown in Table 2.2. It reveals that the overall rating of the students as to their extrinsic motivation is high, which constitutes a weighted mean of 3.50. This means that the students' extrinsic motivation toward learning the subject is highly evident. Moreover, an indicator of extrinsic motivation as the students to have a better grade obtained the lowest average of 2.64. Meanwhile, most of them think that learning mathematics will help them better prepare for the career they have chosen, which resulted in the highest average of 3.96.

Table 2.2. Level of the Students' Extrinsic Motivation in Learning Plane Trigonometry

Intrinsic Motivation	Ave.	Descriptive Response	Level of Motivation
1. Because I need to pass this subject.	2.67	Neither disagree nor agree	Moderate
2. Because I think that learning mathematics will help me better prepare for the career I have chosen.	3.96	Agree	High
3. To prove myself that I am capable of solving a difficult mathematical problem.	3.38	Neither disagree nor agree	Moderate
4. To be a well-known student in the classroom	3.82	Agree	High
5. Because eventually, it is part of the course that I am taking.	4.11	Agree	High
6. Because I can use it in a real-life situation.	3. 59	Agree	High
7. To have an answer to our oral recitation.	3.73	Agree	High
8. Because I want to be top in the classroom.	3.75	Agree	High
9. To show myself that I am an intelligent person.	3.76	Agree	High
10. To have a better grade.	2.64	Neither disagree nor agree	Moderate
Overall Weighted Mean	**3.50**	**Agree**	**High**

Further, intrinsic and extrinsic motivation acquired 3.60 and 3.50, respectively. It means that the manifestation of intrinsic motivation among college students is more evident than extrinsic motivation. The result indicates that the students experienced pleasure and satisfaction in learning new things about plane trigonometry rather than merely passing the subject.

4.2 Academic Performance of the Students in Plane Trigonometry

The level of academic performance of the students in mathematics is shown in table 3. The grades, which were assumed in the study to have been computed objectively, were used as the basis for students' performance. The average grade of the respondents in Math 05 (Plane Trigonometry) is revealed with a rating of 2.60, which is rated as better than average based on the grading system of the Agusan del Sur State College of Agriculture and Technology (ASSCAT). This means that most of the students who were enrolled in the Plane Trigonometry were performing better than average in the subject.

Table 3. Academic Performance of the Students in Plane Trigonometry

Final Grade in Plane Trigonometry	Frequency (n=140)	Description
1.0	**0**	Excellent
1.25	**0**	Superior
1.50	**0**	Very Good
1.75	**2**	Good
2.00	**3**	Highly Satisfaction
2.25	**24**	Satisfactory
2.50	**44**	Better than Average
2.75	**42**	Average
3.00	**25**	Passing
5.00	**0**	Failure
Average Grade	**2.60**	**Better than Average**
Standard Deviation	**0.28**	

4.3 Multiple Linear Regression Procedures in Building the Model for Academic Performance Using Intrinsic and Extrinsic Motivation in Learning Plane Trigonometry

4.3.1 Diagnostic Checking

Diagnostic checking of the multiple linear regression assumptions is presented to determine the adequacy of the identified model. To evaluate the aptness of the model, the required assumptions were tested. The data analysis utilized the different formal tests and generated the results from SPSS software.

Table 4 shows the Kolmogorov-Smirnov result. The statistic associated with the normality test obtained 0.068 with a p-value equal to 0.200, which is higher than 0.05 level of significance. Hence, the error term is normally distributed. The result implies that the distribution of the error terms of the identified model for academic performance is normal. Thus, few consequences associated with a violation of the normality assumption have been eliminated, such as it does contribute to bias or inefficiency in the regression model (Statistics Solutions, 2013a).

Table 4. Normality Test of the Error Terms in the Model

	Kolmogorov-Smirnov		
	Statistic	*df*	Sig.
Unstandardized Residual	0.068	140	0.200

a. Lilliefors Significance Correction

In testing the constancy of variance, the Glejser test was utilized. It is safe to use this test since it can yield an estimate of the specific functional form (whether linear or nonlinear) of the relationship between the variance of the error term and an independent variable. From Table 5, it can be observed that the statistic yielded the values of the intrinsic and extrinsic of 1.850 and -2.541 with *p*-values of 0.066 and 0.072, respectively, which are higher than the 0.05 level of significance. It shows a not significant result for both intrinsic and extrinsic motivation. Thus, it satisfies the assumption of homoscedasticity. This assumption means that the variance around the regression line is the same for all predictors' values, namely intrinsic (X_1) and extrinsic (X_2) motivation. A more serious problem associated with Heteroscedasticity is that the standard errors are biased and have been disregarded (Statistics Solutions, 2013b).

Table 5. Test for Constancy of Variance of the Errors Terms in the Model

Variables in the Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig
	β	Std. Error	Beta		
Intrinsic	.019	.010	.175	1.850	0.066
Extrinsic	-.023	.009	-.240	-2.541	0.072

a. Dependent Variable: AbsUT

For the multicollinearity of independent variables included in the model, Variance Inflation Factors (VIF) are each computed and summarized in Table 6. As shown, the VIF values of the two independent variables are both equal to 1.288. Since the intrinsic and extrinsic VIF values are less than 10 thus, this indicates that there is no presence of multicollinearity among independent variables in the identified model. It implies that the prediction is accurate, and the overall R2 (or adjusted R2) quantifies how well the model predicts the dependent variable (Paul, 2006). In this study, the model will estimate the mathematics achievement of the students.

Table 6. Variance Inflation Factor of the Independent Variable in the Model

Model	Collinearity Statistics	
	Tolerance	**VIF**
Constant		
Intrinsic Motivation (X_1)	0.777	**1.288**
Extrinsic Motivation (X_2)	0.777	**1.288**

Table 7 presents the portion of the probabilities for the D2 scores after sorting in ascending order to find the smallest probability value. It shows that there are no values of less than 0.001. The result implies that there are no cases designated as outliers. Thus, accuracy tended to increase significantly and substantially, and inference errors tended to drop significantly and substantially since extreme scores were excluded in the data analysis (Osborne and Overbay, 2004).

Table 7. Mahalanobis Distance for an Outlier Observation

Observations	Mahalanobis Distance	*p*-value
1	0.04933	0.003
2	0.13146	0.012
3	0.13504	0.013
4	0.15999	0.016
5	0.15999	0.016
:	:	:
140	6.0893	0.890

4.3.2 Model Building for Academic Performance in Plane Trigonometry

Table 8 presents the parameter estimates of the model for academic performance. It shows the outcome of identifying independent variables that will predict the students' academic performance in plane trigonometry.

Table 8. Parameter Estimates of the Model for Academic Performance

Model	β Coefficients	Std. Error	*t* -statistic	Prob. Value
1				
Constant	0.773	0.063	12.344	0.000
Intrisic *(x_1)*	0.250	0.018	13.907	0.000
Extrinsic *(x_2)*	0.255	0.016	16.296	0.000
R-Square				0.864
Adjusted R-Square				0.862

As observed in Model 1, the estimated coefficients are 0.773 for the constant, 0.250 for the intrinsic motivation (x_1), and 0.255 for extrinsic motivation (x_2). The t-test was utilized in testing the significance of the two independent variables. In Table 8, the two variables obtained *p*-values less than 0.05 level of significance. Thus, it indicates that these variables yielded a significant result. Further, the procedure for Backward Elimination terminates the step.

Moreover, the identified model yielded the coefficient of determination R^2 = 0.864, which is relatively high. This statistic implies that the identified independent variables' contribution accounts for 86.40% of the total variation in academic performance (Y). Therefore the generated model in this study takes the form of,

$$\hat{Y} = 0.773 + 0.250X_1 + 0.255X_2.$$

From the regression equation of the final model, the coefficient of intrinsic (X_1) is positive, which implies that Y is directly affected by X_1. This direct relationship means that for every one-point increase in intrinsic motivation (X_1), there is a 0.250 increase in academic performance (Y) while another independent variable is held fixed. On the other hand, the coefficient of extrinsic (X_2) is also positive, which implies that X_2 affects the Y directly. This direct relationship means that for every one-point increase in extrinsic motivation (X_2), there is a 0.255 increase in the academic performance (Y) while another independent variable is held constant.

This study revealed that extrinsic motivation is relatively important with intrinsic motivation in predicting students' academic performance in plane trigonometry. The results coincide with the study of Ayub (2010), which showed that both intrinsic and extrinsic motivations are positive predictors of academic performance.

4.3.3 Predictive Ability of the Model

Table 8 shows the evaluation of the identified model's predictive ability in this study using the Mean Absolute Percentage Error (MAPE %). The model with significant errors is subject to re-evaluation. The final model equation in this study takes the form of,

$$\hat{Y} = 0.773 + 0.250X_1 + 0.255X_2.$$

In this study, 20 cases of hold-out data were used to check if the final model could generate a good prediction. Table 9 revealed the MAPE value of the final model is equal to 0.017. This result indicates that the model gives a lesser error. Thus, the predictive ability of the final model is appropriate for forecasting new cases.

Table 9. The Mean Absolute Percentage Error and the Predicted Values of the identified Model in the Original Form

Cases	Y_i	X_1	X_2	$\hat{Y}_i$	$\left\lvert\frac{Y_i - \hat{Y}_i}{Y_i}\right\rvert$
1	3.00	4.5	4.4	3.02	0.007
2	3.00	4.2	4.5	2.97	0.010
3	2.50	3.2	3.4	2.44	0.024
4	3.00	4.5	4.3	2.99	0.002
5	2.75	3.7	3.9	2.69	0.021
6	2.50	3.2	3.5	2.47	0.014
7	2.50	3.5	3.1	2.44	0.025
8	2.50	3.7	3.1	2.49	0.005
9	3.00	4.1	4.5	2.95	0.018
10	2.50	3.5	3.1	2.44	0.025
11	2.50	4.0	3.0	2.54	0.015
12	3.00	4.3	4.3	2.94	0.019
13	2.25	3.0	2.9	2.26	0.006
14	2.75	3.7	3.9	2.69	0.021
15	2.75	3.9	3.4	2.62	0.049
16	2.75	4.0	3.6	2.69	0.021
17	2.50	3.4	3.3	2.46	0.014
18	2.25	3.1	2.6	2.21	0.017
19	2.50	3.5	3.4	2.52	0.006
20	2.50	3.7	3.3	2.54	0.16
MAPE%	0.017				

5.0 Conclusion and Recommendation

Therefore, based on the findings, it is concluded that intrinsic and extrinsic motivation of the students in learning plane trigonometry can influence the outcome of their academic performance. The final model of this study is deemed necessary since it has proved to be appropriate in forecasting the new cases as per resulting value of the mean absolute percentage error. Thus, to have a good grade in plane trigonometry, students should be intrinsically and extrinsically motivated. Further, the study would like to recommend that teachers should use different activities catering to both students' intrinsic and extrinsic motivation since these are relatively important found in the study to increase students' academic performance in plane trigonometry.

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