Predicting Academic Performance based on Students' Mathematics Motivation

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Abstract: As national development progressively depends on rapid advances in science and technology which in turn require advanced mathematical skills among the country's populace, enhancing students' motivation to learn mathematics skilfully gets more importance than ever before. In this context, a descriptive-regression study was conducted to ascertain the predictive ability of the mathematics motivations of fifty-seven students on their academic performance. Results of the study revealed agreement of students manifesting motivational orientations in learning mathematics in terms of intrinsic & extrinsic goal orientation, task value, and control of learning beliefs. However, they manifest less of self-efficacy in learning mathematics and show a slight of anxiety when they were taking tests. Conducted multiple linear regression analysis showed that intrinsic and extrinsic goal orientations, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety, taken in combination, were significant predictors of students' academic performance. Control of learning beliefs and test anxiety, taken singly, could significantly predict academic performance.

Keywords: Extrinsic & intrinsic goal orientations, task value, control of learning beliefs, self-efficacy, test anxiety

1. Introduction

Mathematics pervades in almost every field of human endeavor (Elastika et al., 2021). Recognized as a major factor of national development, countries are prompted to emphasize mathematics in their national agenda (Adedeji, 2018; Patena&Dinglasan, 2013). These perspectives on mathematics have gained more attention with the rapid advances in science and technology requiring advanced mathematical skills to stay globally responsive and relevant (Yadav, 2019; Andaya, 2014). How students learn and how to measure student performance in mathematics are thus a priority concern of policy makers and educators worldwide. The need for mathematical literacy is going to grow as society becomes more dependent on science and technology, and therefore, improving motivation to learn mathematics for all students is more important than ever before (Jazuli, 2021; Butler, 2016).

Many students view mathematics as difficult (Harun et al., 2021). They are often reluctant to take STEM courses which are heavily laden with mathematics. Thus, they close their opportunity in pursuing careers in science, technology, and engineering (Li &Schoenfield, 2019). This long-standing issue of mathematics and its continued prevalence in today's education system necessitate improving mathematics education. The main goal, however, is to understand what it means for students to be highly engaged and motivated to learn and do mathematics in the present and in the future. Finding factors that motivate and elicit interest among students to learn mathematics could reverse the tide of disinterest and entice them to pursue professions in science, technology, and engineering. It will contribute to the progress of science, technology, and engineering in terms of human resource. Likewise, it will increase knowledge in motivated teaching-learning of mathematics as an indispensable tool in advancing science and technology.

There is a wide acceptance among theorists and researchers that motivation is an important contributor in the academic achievements of students (Tasgin et al., 2018; Wang et al., 2020; Tiffin, 2007). Thus, eliciting students' motivation to learn mathematics is expected to result in academic success. Motivation connects to the idea of fostering interest among students from which it follows that their desire to actively engage in learning activities can be easily elicited if they are properly motivated. The anticipated outcome is that improved levels of motivation will result in more effective participation in class, which in turn, generates high level of student academic performance (Arbabisarjou et al., 2016; Hattie, 2009; Ramirez-Dorantes et al., 2013). Inasmuch as motivation guides students, it can provide prediction of the outcome of mathematical activities (Yavuz et al., 2012).

Within this premise, Pintrich et al. (1991) developed the Motivated Strategies for Learning Questionnaire (MSLQ) which aimed to find factors affecting and increasing the academic achievement of the university students. The MSLQ is anchored on a cognitive-social perspective of motivation and learning strategies wherein students are considered as subjects actively processing information and whose beliefs and cognitions are deemed significant mediators of instructional information and features of the task. As developed by Bandura (1986), the social cognitive model of behavior included goals, expectations, and self-efficacy as vital components of learning process. Bandura, as pointed out by Kivinen (2003), viewed "motivation as goal-directed behavior sustained by the individual's expectations concerning the anticipated outcomes of actions." According to Liu & Lin (2010), the

strength of the students' motivation stimulates them to employ good or bad learning strategies, and in this manner, their academic performance is affected.

1.1. Objectives of the Study

The study was conducted with an objective of ascertaining the predictive ability of motivational orientations of students on their academic performance in Algebra. Specifically, the study intended to know the answers to the following questions:

1. To what extent students agree on manifesting motivational orientations in learning mathematics in terms of value components (intrinsic goal orientation, extrinsic goal orientation, and task value), expectancy components (control beliefs, self-efficacy for learning and performance), and affective component (test anxiety)?

2. Are the motivational orientations of students, taken singly or in combination, significantly predictive of their academic performance in Algebra?

2. Methodology

The study employed the descriptive-regression research in establishing the predictive ability of motivational orientations on the academic performance. Fifty-seven out of 66 first-year engineering students were randomly selected. The collected data were consolidated and tallied in a spreadsheet and subsequently subjected to analyses with the use of statistical software. The seven-point Likert scale was utilized to lend the data for statistical treatment and to provide verbal interpretations. The simple mean were the main descriptive statistics worked out. To determine whether the mathematics motivations were predictors of students' academic performance in Algebra, Multiple Linear Regression Analysis was conducted. The significance test was performed at .05 level of significance.

2.1. Instrument

The main data-gathering tool used was a questionnaire – the Motivated Strategies for Learning Questionnaire (MSLQ). It is "a self-report instrument designed to assess college students' motivational orientations and their use of different learning strategies for a college course" (Pintrich et al., 1991). It was an offshoot of various correlational studies on motivation and self-regulation learning of the students at the National Center for Research with an aim of improving the post-secondary teaching and learning. It was funded by the Office of Educational Research and Improvement, USA. The MSLQ is comprised of two sections, the first of which is the motivation section with 31 items. It involves motivational beliefs of the students. The other section concerns the learning strategies with the same 31 items that tackles the students' employment of various cognitive and metacognitive learning strategies. The items are scored along a seven-point Likert scale that ranges from 1 (not at all true of me) to 7 (very true of me).

The MSLQ, according to Bong (2004), may be utilized as a whole or partially consider only parts of the questionnaire depending on the needs of the researcher. It is extensively utilized in a variety of student groups and fields of specialization in several countries as an instrument of measuring motivation and learning strategies (Karadeniz et al., 2008).

The current study focused solely on the motivational section of MSLQ which consists of three general motivational constructs: value, expectancy and affect. The value component refers to "the reasons students engage in an academic task" whereas expectancy components refer to the "students' beliefs that they can accomplish a given task." The third component, affect, is operationalized by the subscale of test anxiety, which addresses students' concerns and worries of taking exams.

The value component is composed of the following: subscale intrinsic goal orientation with Cronbach (α) coefficient of .74 that tackles students' task participation with motives like challenge, curiosity and mastery; the subscale extrinsic goal orientation (α = .62) which pertains to the perception of participating in a task with goals of good grades, rewards, commendable performance, worthy evaluation of others, and competition; and subscale task value (α = .90) which focuses on students' assessment of the extent the task is perceived interesting, important and useful to them. The expectancy component, however, is composed of the subscale control of learning beliefs (α =.68) that deals with beliefs of students that their efforts to learn will redound to favourable results; the subscale self-efficacy for learning and performance (α = .93) that attends to valuation of one's capacity to perform a task as well as one's confidence in his skills to accomplish that task; and finally, the subscale test anxiety (α =.80), an affective component (Pintrich et al., 1991). Test anxiety is divided into two components: a worry, or cognitive component, which is referred to as the negative thoughts of students that detrimentally affect their test performance; and an emotionality component that focuses on the affective and physiological stimulation attributes of anxiety.

2.2. Data Analysis

The collected data were consolidated and tallied in a spreadsheet and subsequently subjected to analyses with the use of statistical software. The seven-point Likert scale was utilized to lend the data for statistical treatment and to provide verbal interpretations. The simple mean were the main descriptive statistics worked out. To determine whether the mathematics motivations were predictors of students' academic performance in Algebra, Multiple Linear Regression Analysis was conducted. The significance test was performed at .05 level of significance.

2.3. Assumptions of Multiple Linear Regression

Conducting a multiple regression analysis necessitates meeting of several assumptions, some of which were considered in the study, namely, normality, linearity, homoscedasticity, absence of multicollinearity, and independence of errors (Field, 2009; Statistics Solutions, 2021). In performing the data analysis, these assumptions were satisfied and established in the study.

Figure 1 shows the normal distribution of residuals (i.e., differences between observed value of the dependent variable and the predicted value) as they go along the diagonal normality line in the generated normal Predicted Probability plot of the study.

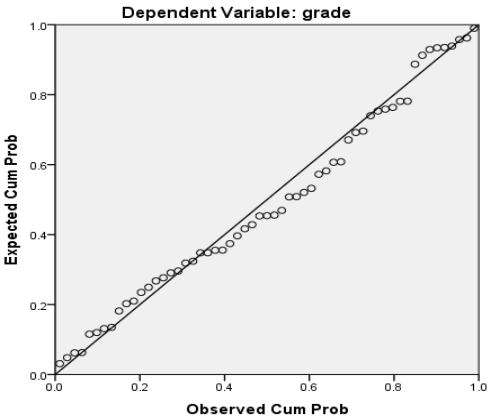

Figure 1. Normal P-P Plot of Regression Standardized Residual

Figure 2 indicates the homoscedasticity of the residuals as they are randomly distributed. If the residuals are normally distributed and homoscedastic, it follows that the residuals are linear (Statistics Solutions, 2021) and such is the case in the study. Multicollinearity, on the other hand, refers to when the predictor variables are highly correlated with one another. If it exists, according to Field (2009), the regression model will not be able to accurately associate variance in the outcome variable with the correct predictor variable, leading to muddled results and incorrect inferences. Absence of multicollinearity is established if the variance inflation factor values (VIF) in the data analysis are below 10.00. VIF values for the six predictor variables of the study were all below 5.00. Finally, the Durbin–Watson test checks whether the residuals (errors) in the model are independent or not. As a conservative rule of thumb, values closer to 2 indicates such independence. In this case, the conducted data analysis generated Durbin-Watson value of 1.601.

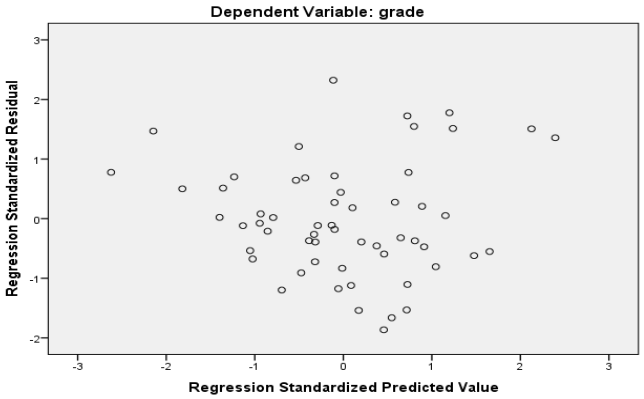

Figure 2. Scatterplot

3.Results and Discussion

The motivational components of MSLQ are based on three general motivational constructs: expectancy, value, and affect. Table 1 shows how these motivational orientations in learning mathematics are manifested by the students.

Table 1. Value, expectancy, and affective motivational orientations of students in learning mathematics (n = 57)

Indicators	*Mean*	Verbal Interpretation
1 Value Component		
a. Intrinsic Goal Orientation	5.38	True of Me
b. Extrinsic Goal Orientation	5.79	True of Me
c. Task Value	5.73	True of Me
2 Expectancy Component		
a. Control of Learning Beliefs	5.31	True of Me
b. Self-Efficacy for Learning	4.58	Somewhat True of Me
3 Affective Component		
a. Test Anxiety	5.13	Somewhat True of Me

Note. 6.16-7.00 (Very True of Me); 5.30 – 6.15 (True of Me); 4.44 – 5.29 (Somewhat True of Me); 3.58 – 4.43 (Neutral); 2.72 – 3.57 (Somewhat Untrue of Me); 1.86 – 2.71 (Untrue of Me); 1.00 – 1.85 (Very Untrue of Me)

The study revealed the extent students manifested the value component of motivation. They were slightly motivated by the course materials which satisfied their inquisitiveness. While they were marginally inspired by their assignments, they derived complete satisfaction from the content materials that provided them fresh and innovative ideas. In essence, the students were *intrinsically motivated* to learn mathematics (*True of Me*) as they were actively participating in learning activities which they viewed with enjoyment, interest, and relevance.

Meanwhile, the students drew fulfilment in getting good grades and satisfaction in showing these to family, friends, and others. To a certain extent, they wanted better grades than most of their classmates. They were likewise motivated by recognition of their ability by others. As they feel the pleasure of learning due to external factors as academic achievement, appreciation, and praise of others, they are *extrinsically motivated* (*True of Me*). In this regard, Zakariya & Massimiliano (2021) observed that students who are intrinsically or extrinsically motivated to learn mathematics generally demonstrate higher performance than others who are not motivated.

The students were similarly aware of the *task value* of learning mathematics (*True of Me*). They regarded Algebra as very important. They displayed keen interest in the subject matter which they could use in other subjects. In general, they personally view mathematics as interesting, useful, and important. Oyuga et al. (2019) confirmed students who give emphasis on task values guide them to good academic performances.

The study further disclosed that the students sometimes saw themselves at fault not exerting enough effort in times they failed to learn the course material. Nonetheless, if they studied properly, they were certain they will learn the subject. In effect, students were more motivated to learn when they feel they are in control of their own successes and failures. And in such situation, they feel enough *control of their learning beliefs* (*True of Me*).

As to *self-efficacy for learning*, the study found that the students were a bit unsure of good performance in mathematics (*Somewhat True of Me*). They had difficulty in understanding the most complex materials of the course and were less confident in accomplishing their assignments. However, they were certain they grasped the basic concepts of mathematics. In effect, the students were fairly motivated by their individual abilities and skills to learn mathematics. As pointed out in the study of Güvendir (2016), there existed a relationship between self-efficacy and mathematics achievement. Students who thought they have enough potential to cope with mathematics had higher scores than students who did not feel any potential to learn. Students who were more confident in their abilities tend to perform better, solved problems more efficiently, checked their progress consistently, hence, achieved effectively than their colleagues who did not possess self-efficacy (Sartawi et al., 2012).

And finally, the study exposed a fair level of *test anxiety* among students (*Somewhat True of Me*). They felt their heart beating at the beginning. During the examination, they were conscious of items they could not answer with possible failure crossing their minds. They contemplated on their poor performance compared with other students, thus, upsetting them. Roodbarde et al. (2017) declared that test anxiety is one of the most significant

negative elements of motivation, with unpleasant effects on students' performance. In a study conducted by Almalki (2019), test anxiety was found negatively correlated with the students' academic performance. With the existence of pessimistic thoughts, it influences motivation and hinders the learning process (Anais et al., 2012).

3.1.Multiple Regression Analysis

A multiple linear regression was calculated to predict the students' academic performance in Algebra based on independent variables, namely, intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety.

As shown in Tables 2 and 3, the regression model was significant with F (6, 50) = 6.618, p< .001, R^2= .443, *adjusted* R^2 = .376. The 37.60% variance in the academic performance of the students is explained by the joint effects of the six learning motivations. The most important predictors are test anxiety and control of learning beliefs as indicated by their beta coefficients of -3.428 and 2.967, respectively.

Table 2. Multiple regression performed between dimensions of value, expectancy, and affective motivations and students' academic performance in Algebra (n = 57)

Source	*B*	*SE B*	β	*t*	*p*
(Constant)	35.923	11.512		3.120	.003
Intrinsic Goal Orientation	2.945	1.649	0.242	1.786	.080
Extrinsic Goal Orientation	1.198	1.127	0.122	1.064	.293
Task Value	1.747	1.628	0.143	1.073	.288
Control of Learning Beliefs	2.967	1.241	0.286	2.391	.021*
Self-Efficacy for Learning	0.554	1.506	0.052	0.368	.715
Test Anxiety	-3.428	1.174	-0.342	-2.920	.005**

Note. R = .665; R^2= .443; *Adjusted* R^2= .376;*p < .05; ** p< .01

Thus, taken in combination, motivational orientations in learning mathematics, namely, intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning & performance, and test anxiety, were significant predictors of students' academic performance. Control of learning beliefs and text anxiety, taken singly, are significant predictors of students' academic performance as indicated by generated probability values of p < .05 and p< .01, respectively.

Table 3. Analysis of variance (ANOVA) table for multiple regression performed between dimensions of value, expectancy, and affective motivations and students' academic performance in Algebra (n = 57)

Source	*SS*	*df*	*MS*	*F*	*p*
Regression	1724.310	6	287.385	6.618	0.000
Residual	2171.269	50	43.425		
Total	3895.579	56			

In support of these findings, Barton et al. (2021) stated that, when motivation was considered as a predictor, it significantly predicted academic performance. Motivation can lead students to pursue opportunities to learn, which is likely to result in increased effort, more practice, faster skill development, and higher academic achievement. In a similar manner, the study Mokgwathi et al. (2019) disclosed that students that like learning mathematics and value mathematics perform better than students who do not like it and who do not value it. It likewise revealed that students who feel confident in mathematics have better performances compared to those who are not confident.

However, findings of the study of Tus (2020) contradict the results of the current study. As they are nearing college life, senior high school students in the said study perceived that getting better academic performance yields better opportunities in life. It became an enormous burden on the part of the students to perform well in high school. The results of the study showed stress and motivation have no significant relationship with students' academic performance. The stress very well negated the students' motivation to academically perform appropriately.

The study of Liu et al. (2020) also revealed that motivation was detrimental to the academic performance of Chinese students. Considered as an extrinsic motivation, learning for Chinese students is seen as their duty and obligation to the society and their parents. This situation was taken as an extra pressure on students, thus, negatively affected their academic performance.

Tripathi et al. (2018), on the other hand, were able to prove in their study that intrinsic factors of motivation are strong predictors of academic performance. In increasing the motivation of the students, they more likely

perceived the academic tasks to be meaningful. Motivation is acknowledged as a precondition and a necessary element to get student engaged in learning.

Results of the current study are similarly in agreement with the findings of Muwonge et al. (2019) stipulating that students' control of learning beliefs strongly influenced their critical thinking and organization skills, which in turn strongly contributed to their academic performance. The same goes with the findings of Manzano-Sanchez et al. (2018). Results of their study showed significant and positive relationship between self-efficacy and academic performance of students. In the same vein, self-efficacy with emotional intelligence and self-esteem, according to Ugwuanyi et al. (2020), significantly predict learners' academic achievement in mathematics.

With regard to anxiety, the results of the study of Rodriguez et al. (2020) indicated that success in mathematics is negatively related to negative feelings and mathematical anxiety. They found out that anxiety and negative feelings are higher in students with low performance than in successful students in mathematics.

4.Conclusion

The current study aimed to determine the extent students agree on manifesting motivational orientations in learning mathematics and to ascertain the predictive ability of these motivations on their academic performance. Results of the study revealed that the students were motivated to learn mathematics. They drew sufficient gratification in getting good grades and recognition of their ability by others. They believed that achievement in mathematics depends on the extent they exert effort in learning it. To a certain degree, they were confident in their individual abilities and skills to learn mathematics, and still feel the anxiety in taking examinations. Taken in combination, motivational orientations in learning mathematics, namely, intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning & performance, and test anxiety, were significant predictors of students' academic performance. These underscore the importance of students' motivational orientations to academic performance. The findings have implications for mathematics teachers to motivate their students during their instructions. They must recognize the basic motives already existing in their students and then play on these motivations to optimize engagement and improve the effectiveness of the teaching-learning process. They can involve students actively in satisfying their mathematical curiosities. The teachers may also present students with mental challenges. They can help students set learning goals to work on and show them how they can be used in their lives. When students make this connection, they will be able to appreciate how important mathematics is in their day-to-day activities. Through self-evaluation and reflections, students will be more aware of their own beliefs on mathematics and on their abilities to adopt more positive levels of motivation. Finally, findings of the study may be used as resource materials by school administrators, mathematics teachers, counsellors, parents, and significant others who are concerned with the academic success of their students.

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