Statistical Modelling of Factors affecting Performance of Students in Secondary Schools in Tanzania

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ABSTRACT

Over the last decade, secondary schools in Tanzania have failed to produce enough graduates who are able to join higher level of schooling (Advanced level). Only less than 35% of students were able to score between division one and three. The aim of this study was to develop a factor model with factors affecting the overall performance in secondary schools in certificate of secondary national examinations in Tanzania. Data was collected from 26 secondary schools in Dar es salaam and Arusha using self-administered questionnaire. The questionnaires had 16 Likert type questions in five-point scale ranging from strongly disagree to strongly agree. The findings from factor analysis indicated that three factors namely "school culture", "supportive learning environment "and "teacher satisfaction with the school" explained 74.8 percent of total variation in overall performance in certificate of secondary education examination. Multiple Linear regression revealed that supportive learning environment had a significant effect on overall performance in terms of school Grade Point Average. It is concluded that in order to improve overall performance, schools and the government should create supportive learning environment by employing more teachers, ensuring availability of books are timely and adequately available and the availability of library and laboratories. Further studies should add the qualitative part so as to gather more information about schools and other factors which were not considered under this study.

Keywords: Likert-type questions, overall performance, Factor analysis, Multiple linear regression.
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1. INTRODUCTION

Educational accountability requires mutual action between government, schools and the community. To improve performance and meet public expectations, schools depend on financial, technical and logistical support in terms of fund, teaching and non-teaching staff and other learning facilities [1]. Performance of institutions such as schools is influenced by several factors such as funding and overall learning environment [2]. This study focuses on the problem of secondary school students not performing well in certificate of secondary education examinations results in Tanzania in terms of the overall performance. Data show that over a decade less than 35% of students each year score from division one to three [3]. This results in many students lacking qualifications to join the next level of schooling (advanced level). Further, there is an increasing trend of repeaters, for instance, from 2.4% in 2019 to 11% in 2020 [3] . All these show there is need for schools to do more to improve performance so as to enable a significant proportion of the students in Tanzania get to the higher level of education (Advanced level) and meet their life expectations and to reduce the trend of repeating.

Numerous studies have been conducted on factors affecting performance of individual students [4-6]. Various factors such as learning environment [7], school culture [8] and school resources [9] have been mentioned to affect performance of individual students in specific subjects. However, not enough attention has been paid on the overall performance in secondary schools, especially for Tanzania case. Overall performance in secondary schools is important because it can be seen as an indicator of the ability of a school to meet learners and community expectations of acquiring knowledge. Therefore, this study intended to formulate a mathematical model describing factors affecting the overall performance in secondary schools and assess the contribution of each factor on overall performance.

1.1 The factor analysis model

The factor analysis model is given as

$$x_i = \Lambda\eta_j + \epsilon_i \qquad (1)$$

$$i = 1, 2, 3, \dots, p; j = 1, 2, \dots, m$$

Where x_i is a column vector of p observed random variables; η_j is a column vector of m rows of latent variables (factors); ϵ_i is a $p \times 1$ vector of random error variables; Λ is an $p \times m$ matrix of factor loadings. The factor model has the property that partial correlations between the variables remain zero after factors are extracted [10].

1.2 Multiple Linear Regression

The Multiple Linear regression equation is given as

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \qquad (2)$$

Where Y = dependent variable; α is an intercept; X_i for $i = 1,2,3, \dots, n$ are the independent variables/factors; β_i are coefficients of X_i;

1.3 Correlation Analysis model

The formula for Pearson Product Moment Correlation coefficient is written as

$$r = \frac{\frac{1}{N}\sum xy - \bar{x}\bar{y}}{\sqrt{\left(\frac{1}{N}\sum x^2 - \bar{x}^2\right)}\sqrt{\left(\frac{1}{N}\sum y^2 - \bar{y}^2\right)}} \qquad (3)$$

Where r = Pearson Product Moment Correlation coefficient; N = Number of pairs of values or scores; $\sum xy$ = Sum of products of x and y; $\bar{x}$ = Mean of x values; $\bar{y}$ = Mean of y values; $\bar{x}\bar{y}$ = Product of the mean values of x and y;

$\sum x^2$ = Sum of squares of x values; $\sum y^2$ = Sum of squares of y values

2. RELATED WORK

This section discusses various areas and studies where factor analysis, principal components, multiple regression and correlation analysis have been applied in education research.

To begin with a study conducted by Gilbert, C., & Magulod, J. to determine the factors of school effectiveness and school performance in the Second Congressional District of Cagayan Province, Philippines, factor analysis by principal component was used to identify the principal components of school effectiveness of public and private elementary schools. Their study involved 182 teachers and administrators from 20 sampled schools. Effective school correlates were used to measure school effectiveness and school performance was measured using National Achievement Test (NAT) results. The study identified that school performance was influenced by school leadership competence and professional collaboration. It was further identified that school effectiveness and school performance are strongly positive related [11].

Factor analysis and correlation analysis were employed in a study conducted by Tibus, E. D to analyze data of 250 college students for the purpose of determining the contribution of academic stress on English academic performance and to investigate their level of academic performance [12]. The study identified four factors namely perceived personal stress, classroom stress, performance stress and time management stress, further findings suggest that the students had a moderate level of academic stress. However, no factor was found to have a significant correlation with English performance

kansatra Tangaraju et al. conducted a study to analyze factors affecting academic performance of undergraduate students in Kampar. The study employed factor analysis and regression analysis[13]. Factor analysis was used to identify the factors of student performance and regression analysis was used to study the relationship between the factors and the academic performance. The factors such as teaching methods, time management, attendance of students, and sleep were found to have positive and significant influence on academic performance while social ideology is found to influence academic performance negatively.

Ramli, A et al.,conducted a study to examine the influence of environmental factors on student's academic performance. The study used the regression and correlation analysis to analyze data gathered through administered questionnaire. The study found out that the three environmental factors namely infrastructure and services, pollution and health environment and environmental hazard had significant influence on the academic performance of students. Moreover, the three factors also were found to have a consequential influence on the student quality of life [14].

Kisakali, J. et al., conducted the study to investigate the factors affecting mathematics performance in Arusha and Kilimanjaro regions in Tanzania. PCA method was used to identify uncorrelated factors affecting performance in mathematics. A regression model was developed based on the identified factors of student performance in mathematics. In the study, it was identified that lack of qualified teachers, lack of interest while studying mathematics, triviality and lack of practice by students, lack of drive (desire) and enthusiasm for teachers and students, perception and attitude towards the subject terming it to be difficult are the main contributors towards poor performance in mathematics [6].

3. MATERIAL AND METHODS

3.1 Data Collection

A questionnaire containing structured questions was prepared and distributed to secondary school teachers of both public and private schools in Arusha and Dar es salaam regions in which a total of 26 schools were visited. During pilot study, teachers were asked to comment on relevance of the questions and the language used. Schools visited for the pilot study were not included in the sample. A questionnaire had a total of 18 questions/variables divided into two parts. The first part contains demographic information and the second part contains the variables. Each teacher was required to answer all questions from the questionnaire. Responses gathered from each single school were averaged so as to come up with a common information about the school. School GPA in form four national examination results were collected from school academic offices because they were used to measure the performance of a school in form four national examinations. The Bonett's sample size formula was used to calculate the sample size for less than 30 samples [15].

3.2 Data Analysis

To determine whether the data collected was suitable for factor analysis, values for Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO) and Bartlett's test of sphericity were computed [10]. The value of KMO was found to be 0.787. [16] asserts that for factor analysis to be conducted on collected data, the KMO value must be at least 0.5. The Bartlett's test of sphericity was computed and found to be $p = 0.000$ indicating that the data was highly suitable for factor analysis as required by the test [10]. Thus all 16 variables in a questionnaire were suitable to be included in the analysis.

Factor Analysis by Principal component Analysis (PCA) using Statistical Package for Social sciences (SPSS) version 23.0 and Microsoft Office Excel was performed on the data set to extract the influential factors of overall performance. [17] asserts that factors with eigen value greater than 1 should be extracted, thus eigen value was set equals to 1 during factor analysis. This resulted to three components/factors. Oblique rotation by Direct Oblimin was performed on the components so as to obtain the pattern matrix which produced correlated factors [10]. Structure matrix was obtained as result of rotating the pattern matrix so as to shows the resulting correlations between the factors and the variables. The factors with significant loadings above 0.5 were retained. The aim of rotating factors was to improve interpretation of the factors since it gives a solution in which each variable has a small number of large loadings [10]. This made each factor having at least three variables [10].

Multiple regression models were developed to establish the relationship between the identified factors and overall performance [18]. Lastly, Pearson product moment correlation analysis was performed to identify the strength of the relationship between the extracted factors [19].

4. RESULTS

4.1 Factor Analysis Model

The resulting factor analysis model equations are given as

$$x_i = \begin{bmatrix} 0.921 & 0.436 & 0.213 \\ 0.914 & 0.307 & 0.268 \\ 0.849 & 0.300 & 0.533 \\ 0.839 & 0.647 & 0.103 \\ 0.837 & 0.103 & 0.281 \\ 0.819 & 0.544 & -0.034 \\ 0.724 & 0.550 & -0.037 \\ 0.704 & 0.321 & 0.279 \\ 0.196 & 0.901 & 0.053 \\ 0.465 & 0.872 & 0.256 \\ 0.425 & 0.805 & 0.324 \\ 0.353 & 0.692 & -0.034 \\ 0.432 & 0.671 & 0.432 \\ 0.533 & 0.385 & 0.825 \\ 0.067 & 0.055 & 0.821 \\ 0.583 & 0.462 & 0.797 \end{bmatrix} \begin{bmatrix} F_1 \\ F_3 \\ F_3 \end{bmatrix} + \begin{bmatrix} 0.151759 \\ 0.164604 \\ 0.279199 \\ 0.296079 \\ 0.299431 \\ 0.329239 \\ 0.475824 \\ 0.504384 \\ 0.188199 \\ 0.239616 \\ 0.277500 \\ 0.521136 \\ 0.549759 \\ 0.319375 \\ 0.325959 \\ 0.364791 \end{bmatrix} \quad \text{for } i = 1,2,3,\dots,16.$$

Factor 1 (F_1), includes the variables; The staff are on harmonious terms x_1, The head of school shows interest in my personal growth and development x_2, The head of school trusts me with high responsibility and assignments x_3, Students are confident in learning x_4, The staff cooperate each other happily x_5, Students are interested in learning x_6, Students take initiative to learn x_7, School's discipline and guidance work is geared to students' academic development x_8 was named as school culture and was explained by 33.9% of the total variations in overall performance.

Factor 2 (F_2) includes the variables; The school has enough teachers x_9, There are enough books and other learning materials x_{10}, Library and laboratories are in good number and condition x_{11}, Parents/guardians are committed to the academic development of their children x_{12}, Chairs and tables are available to most students x_{13} was named as supportive learning environment and was explained by 24.37% of the total variations in overall performance

Factor 3 (F_3) includes the variables; The school decision making process is transparent x_{14}, The school has clear direction of developmentx_{15}, I find satisfaction in working at this school x_{16} was named as teacher satisfaction with the school, was explained by 16.6% of total variations in overall performance. The three factors together explain 74.8% of the variation in overall performance in certificate of secondary education examinations

4.2 Multiple Linear Regression model

Table 4.2. 1 Multiple Linear Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.536[a]	0.288	0.191	0.219983
a. Predictors: (Constant), teacher satisfaction with school, supportive environment, school culture				

The Multiple Linear regression model had the coefficient of determination, $R^2 = 0.288$, indicating that the variance in the overall performance (school GPA) was explained by the three factors by 28.8% percentage.

Table 4.2.2 Multiple Linear Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.472	0.219		20.459	0	4.018	4.925
	school culture	-0.006	0.071	-0.017	-0.078	0.939	-0.153	0.142
	supportive environment	-0.145	0.063	-0.51	-2.311	0.031	-0.275	-0.015

| teacher satisfaction with school | -0.009 | 0.055 | -0.034 | -0.156 | 0.877 | -0.123 | 0.105 |

a. Dependent Variable: Grade Point Average

The Regression equation was given as performance = 4.472 – 0.06(School culture) – 0.145(supportive environment) – 0.009(teacher satisfaction with school) indicates that a unit change in school culture affects school performance by 6% and a unit change in supportive environment affect s school performance by 14.5% while a unit change in teacher satisfaction with school affect school performance by 9%. Negative sign indicates increasing quantities of the factors would increase the school GPA (higher GPA's are close to 1). One factor, supportive teaching and learning environment, had high and significant effect on overall performance in secondary schools in certificate of secondary education examinations in Tanzania (see Table 4.2.2). Other factors such as School culture and teacher satisfaction with the school did not affect overall performance significantly. The model was significant at $\alpha = 0.05$.

4.3 Correlation Model

Table 4.3. 1 Correlations between the factors

		school culture	Supportive environment	Teacher satisfaction with school
School culture	Pearson Correlation	1	.532[**]	. 490[*]
	Sig. (2-tailed)		.005	.011
Supportive environment	Pearson Correlation	.532[**]	1	.461[*]
	Sig. (2-tailed)	.005		.018
Teacher satisfaction with school	Pearson Correlation	.490[*]	. 461[*]	1
	Sig. (2-tailed)	.011	.018	

The correlation analysis revealed that there is moderate-positive relationship between school culture and supportive learning environment also there is moderate-positive relationship between school culture and teacher satisfaction with school and supportive learning environment and teacher satisfaction with the school. All correlations are significant. The results suggest that the three factors influence each other.

5. DISCUSSION

Factor analysis was performed so as to extract the most influential factors of overall performance in secondary schools in certificate of secondary education examinations in Tanzania. The formulated model identified three factors extracted out of sixteen variables. The identified factors were named accordingly. These factors are school culture, supportive learning environment and teacher satisfaction with school. The three factors explained 74.8% of total variation in overall performance of secondary schools. The correlation analysis revealed that there is moderate to positive relationship between school culture and supportive learning environment. Also, there is moderate to positive relationship between school culture and teacher satisfaction with school and supportive learning environment and teacher satisfaction with the school and all correlations are significant. The result suggests that the three factors influence each other.

A multiple linear regression model was developed so as to identify the contribution of each factor on overall performance. In this model, the school Grade Point Average (GPA) was used as the dependent variable while the extracted factors were the predictors. Results of the Multiple linear regression suggests that one factor namely supportive environment had high significant effect on overall school performance. This factor was observed among factors affecting performance of students in a study conducted by [20]. The three factors together explained 28.8% of total variation in overall performance in secondary schools in certificate of secondary education examinations.

6. CONCLUSION

Based on the findings, the study concludes that supportive learning environment has a significant effect on overall performance in secondary schools in the certificate of secondary education examination in Tanzania. That means, in schools where there are supportive learning environments for students, there is a good chance to have better overall performance.

These findings give a clear picture that school administrators should focus on creating a supportive teaching and learning environment to students and teachers. The government should hire more teachers, buy text books, ensuring availability of library and laboratories as well as other teaching and learning resources. Overall environment of schools should be improved by ensuring that the necessary resources are timely available to teachers and students so that learning and teaching is not hampered. Involving parents in academic matters is important because parents are responsible in providing supportive environment to students at home. Also, involving parents can be a tool to arouse positive behavior among students and influence academic performance of students and the school at large.

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