Application of Multiple Linear Regression in Identifying Contributing Factors in Students' Academic Achievement

Dg Siti Nurisya Sahirah Binti Ag Isha and Siti Rahayu Binti Mohd Hashim[✉]

Mathematics With Economics Programme, Faculty of Science and Natural Resources, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia
rahayu@ums.edu.my

Abstract. Academic achievement is defined as the capacity to study, recall information or facts, and transmit knowledge in written or verbal form. It is one of the most essential measures of comprehension and learning in all educational systems. It is crucial to identify the factors that would affect students' achievement to enhance their achievement in academics. Hence, this research was intended to determine the significant factors that contribute to educational success. This study included internal factors such as self-esteem, emotional intelligence, intelligence, and the students' personalities, whereas parental education and household income were used as the external factors. Students' academic success was measured using their cumulative grade point average. This study involved 327 final-year undergraduate students from the Faculty of Science and Natural Resources and was selected through a stratified sampling method. The data were analysed using stepwise multiple linear regression. Three regression models have been developed: the internal factors model, the external factors model, and the combined internal and external factors model. The three models were compared for the identification of significant contributing factors. The internal factors model exposed that self-esteem and intelligence were significant factors in educational achievement while the external factors model showed that only maternal education was a significant factor in students' performance. The combined internal and external factors model discovered that maternal education together with self-esteem were significant factors affecting students' achievement. The findings indicated that self-esteem, intelligence, and maternal education were significant factors in students' learning outcomes. Therefore, it is highly recommended for the government to collaborate with university administration, educators, and parents to develop strategies or programs focusing on these three factors to improve students' academic performance.

Keywords: Academic achievement · Emotional intelligence · Intelligence · Multiple Regression

1   Introduction

Academic achievement is defined as the capacity to study, recall information or facts, and transmit knowledge in written or verbal form [1]. It is one of the most essential measures

of comprehension and learning in all educational systems [2]. Due to the development of science and technology, society and the world are changing rapidly which leads to competition in academics in order to comply with this advancement [3]. Furthermore, the academic achievement of students has become one of the biggest interests of parents, educators, and authorities. Thus, efforts have been initiated to prevent students from failing in their academics [4]. Hence, it is crucial to identify the factors that would affect students' achievement to enhance their educational achievement. As a result, the objective of this study was to determine the significant internal and external factors that contribute to students' success.

Internal factors and external factors were two types of factors focused on in this research. Internal factors are factors that came from the students themselves [5]. This study included internal factors such as self-esteem, emotional intelligence, intelligence (IQ), and the students' personalities. Self-esteem is defined as a person's inner appraisal or evaluation of himself or herself [3]. Prior studies conducted by [2, 6, 7] revealed students' self-esteem was positively associated with their academic performance. This suggested that students with higher self-esteem are more likely to excel academically than those with lower self-esteem [1]. [6, 8] found self-esteem was one of the relevant factors in educational success.

Emotional intelligence is another factor constantly mentioned by many researchers [4]. It is described as the ability to recognize, analyse, and transmit emotions [9]. Students with higher academic success showed higher levels of emotional intelligence [10]. Studies led by [11, 12] discovered that emotional intelligence is positively associated with students' educational success. Otherwise, [4, 13, 14] found that emotional intelligence did not significantly associate with students' academic achievement. Besides, the majority of studies have found that IQ was a significant contributing factor for learning outcomes [15]. General intelligence, often known as fluid intelligence, is frequently tested using inductive and deductive reasoning tests [16]. It represents a person's capacity to ponder, think, solve a range of complex problems, and draw conclusions.

To put it another way, IQ is the ability to recognize complex relationships and solve problems. Studies by [15–19] revealed that IQ was positively associated with students' educational achievement. Some researchers [15–18] discovered that students' IQ has become a predictor of their performance. Additionally, personality traits is another factor that would affects students' academic achievement [20]. Personality can be defined as the way a person thinks, speaks, behaves, and sustains that expresses her or his differences [21]. The Big Five theory proposes five core traits: openness, conscientiousness, agreeableness, neuroticism, and extraversion [22, 23].

Openness is associated with being inventive, insightful, inquiring, artistic, and interested in a variety of issues while conscientiousness is defined as being dependable, organized, responsible, detail-oriented, self-control, and diligence [22]. Being sympathetic, attentive, altruistic, and behaving helpful in a way that expects others to behave equally is the characteristic of agreeableness [23]. The term neuroticism relates to a person's level of emotional stability, anxiety, and impulsive control meanwhile extraversion is characterized by a higher level of assertiveness, sociability, and talkativeness [24]. Conscientiousness consistently became one of the factors that are relevant to educational success [18]. This meant that students who scored high on conscientiousness were more

likely to obtain higher grades in their academics. In contrast, [25] have exposed that personality traits did not significantly predict students' success. Nevertheless, [22] discovered that students that scored high on conscientiousness and openness will be more successful at university.

Socioeconomic status, such as parental education and household income, were external factors focused on in this study. There was an effect of parental education on their children's academic success [26]. [27] discovered that maternal education was one of the contributing factors to students' educational achievement. The study conducted by [28] revealed that household income significantly affects students' performance.

2 Methodology

2.1 Population and Sampling

This research was carried out on the main campus of Universiti Malaysia Sabah (UMS) in Kota Kinabalu, using undergraduate students from the Faculty of Science and Natural Resources as the target group. The study's sample size was determined by Krejcie and Morgan (1970) [29] and 327 final-year students who graduated in 2021 were selected using a stratified sampling method.

2.2 Instruments

The questionnaires consisted of five sections. The first section aimed to determine students' demographic profiles such as gender, parental education, household income, and academic achievement (CGPA). The second section aimed to assess students' self-esteem by using the Rosenberg Self-Esteem Scale [30]. It consisted of ten items with a four-point scale and Cronbach's Alpha for this instrument was 0.83.

The third section was the Wong and Law Emotional Intelligence Scale [31] which aimed to evaluate students' emotional intelligence. It consisted of 16 items and had a seven-point Likert scale. The Cronbach's Alpha for emotional intelligence and its dimension exceeded 0.80. The fourth section consisted of an IQ test and it was roughly structured following Raven's Progressive Matrices [32]. It consisted of 25 items, each of which has a visual geometric design with a missing component that the respondents have to identify. Cronbach's Alpha for this instrument was 0.82.

The last section consisted of the Big Five Inventory (BFI) which aimed to examine students' personality characteristics. It was created by John [33] and each item had a five-point Likert scale and the Cronbach's Alpha for conscientiousness, agreeableness, extraversion, openness, and neuroticism were 0.73, 0.69, 0.69, 0.78, and 0.74 respectively.

2.3 Statistical Analysis

The data were analyzed with SPSS version 28. Descriptive analysis was used to present some information about specific variables and to describe the respondents' demographic background. To discover the significant factors affecting students' academic achievement, stepwise multiple linear regression was used.

Stepwise Multiple Linear Regression

Stepwise multiple regression was employed to identify the internal and external factors that are relevant to academic performance. This approach combines forward and backward selection methods, allowing researchers to go in both directions while adding and deleting variables at various stages [34]. There were three types of regression models that have been developed which consisted of the internal factors model, the external factors model, and the combined internal and external factors model. The internal factors model consisted of four main factors which were self-esteem, emotional intelligence, IQ, and the facets of personality traits as the independent variables. The external factors model comprised parental education and household income, and the third model was the combination of both internal and external factors.

The internal factors model:

$$
\begin{aligned}
y = &\beta_0 + \beta_1 x_{SE} + \beta_2 x_{EI} + \beta_3 x_{IQ} + \beta_4 x_{EX} + \beta_5 x_{NEU} \\
&+ \beta_6 x_{AG} + \beta_7 x_{CONS} + \beta_8 x_{OP} + \varepsilon
\end{aligned}
\tag{1}
$$

where y is academic achievement, β_0 is the regression intercept, β_1, β_2, β_3, ..., β_8 are the regression coefficients, x_{SE} is self-esteem, x_{EI} is emotional intelligence, x_{IQ} is IQ, x_{EX} is extraversion, x_{NEU} is neuroticism, x_{AG} is agreeableness, x_{CONS} is conscientiousness, x_{OP} is openness, and ε is the error term.

The external factors model:

$$
\begin{aligned}
y = &\beta_0 + \beta_1 x_{SE} + \beta_2 x_{EI} + \beta_3 x_{IQ} + \beta_4 x_{EX} + \beta_5 x_{NEU} \\
&+ \beta_6 x_{AG} + \beta_7 x_{CONS} + \beta_8 x_{OP} + \varepsilon
\end{aligned}
\tag{2}
$$

where y is academic achievement, x_{FP} is paternal education (primary), x_{FS} is paternal education (secondary), x_{FT} is paternal education (tertiary), x_{MP} is maternal education (primary), x_{MS} is maternal education (secondary), x_{MT} is maternal education (tertiary), x_{HI2} is income (RM1000-RM3000), x_{HI3} is income (RM3001-RM5000), x_{HI4} is income (>RM5000). The variable no formal education and household income (<RM1000) became the reference groups.

In simple matrix form,

$$
y = X\beta + \varepsilon
\tag{3}
$$

$$
\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1k} \\ 1 & x_{21} & x_{22} & \cdots & x_{2k} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{nk} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}
\tag{4}
$$

Using the OLS method, the regression coefficient:

$$\hat{\beta} = \left(X^T X\right)^{-1} X^T Y \tag{5}$$

where n is the number of observations, k is the number of parameters, X^T is the transpose of matrix X, and $\left(X^T X\right)^{-1}$ is inverse of $X^T X$.

To test the overall significance of the regression coefficient in the model, the following test was performed. The hypothesis testing for this test is shown below.

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \cdots = \beta_k = 0$$

$$H_1 : \text{ at least one } \beta_i \neq 0 \text{ for } i = 1, \ldots, k$$

Test statistic value:

$$F_s = \frac{\sum_{i=1}^n \left(\hat{y}_i - \bar{y}\right)^2 / k-1}{\sum_{i=1}^n \left(y_i - \hat{y}_i\right)^2 / n-k} \tag{6}$$

Follow F-distribution with $k - 1$ and $n - k$ df. The hypothesis null was rejected if the $F_s > F_{k-1,n-k,\alpha}^*$. $\hat{y}_i$ is the fitted value of y_i, $\bar{y}$ is the mean value, k is the number of estimated parameters including constant term.

Then, hypothesis testing on individual regression coefficients was carried out to determine the significant variable in the model. The hypothesis testing for this test is shown below.

$$H_0 : \beta_i = 0, \qquad H_1 : \beta_i \neq 0 \qquad \text{for } i = 1, \ldots, k$$

Test statistic value:

$$t_s = \frac{\hat{\beta}_i - \beta_i}{s_{\hat{\beta}_i}} \tag{7}$$

Follow t-distribution with $n - k$ df.

The null hypothesis was rejected if the $t_s > t_{n-k,\frac{a}{2}}^*$ or $t_s < -t_{n-k,\frac{a}{2}}^*$.

where β_i is the hypothesized value (0), $\hat{\beta}_i$ is the least square estimator of β_i, and $s_{\hat{\beta}_i}$ is the standard error.

The model fitness was assessed by using MSE, RMSE, and adjusted R^2. The best model among candidate models is the one that yields the smaller value of MSE, RMSE, and the larger adjusted R^2 [35].

The formula for MSE:

$$MSE = \frac{\sum_{i=1}^n \left(y_i - \hat{y}_i\right)^2}{n - k} \tag{8}$$

The formula for RMSE:

$$RMSE = \sqrt{MSE} \tag{9}$$

The goodness of fit is usually measured by R^2, however, the problem exists where the addition of a new independent variable (whether or not it is significant to the model) will increase the value of R^2[36]. Therefore, the adjusted R^2 used to penalize the addition of new variables that are not significant for the model. The formula for adjusted R^2 is shown in Eq. (10).

$$= 1 - \left(\frac{n-1}{n-k}\right)\left(1 - R^2\right) \tag{10}$$

where

$$R^2 = 1 - \frac{\sum_{i=1}^{n}\left(y_i - \hat{y}_i\right)^2}{\sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2} \tag{11}$$

The multicollinearity was assessed by using the variance inflation factor (VIF) and tolerance value. The formula of tolerance and VIF are shown below.

$$Tolerance = 1 - R^2 \tag{12}$$

$$VIF = \frac{1}{1 - R^2} \tag{13}$$

3 Research Findings

3.1 Descriptive Analysis

The frequency and percentage of socio-demographic factors are shown in Table 1. This study comprised 327 undergraduate students, with females accounting for 75.2% of the respondents and males accounting for just 24.8%. Many of the students hailed from low-income families with both parents having a secondary education.

3.2 Multiple Linear Regression

There were three types of regression models that have been developed which consisted of the internal factors model, the external factors model, and the combination of internal and external factors model. Table 2 summarizes the result of multiple regression analysis for the three models. The first model of internal factors model revealed that self-esteem was a significant factor in students' achievement and the regression equation for this model was significant ($F(1, 325) = 6.528$, p $= 0.011$, R2 $= 0.020$, $R^2_{adj}= 0.017$). The second model showed that self-esteem and IQ were the significant factors that contribute to students' grade which reached statistical significance ($F(2, 324) = 5.462$, p $= 0.005$, R2 $= 0.033$, $R^2_{adj}= 0.027$). The regression equation for external factors model was significant ($F(1, 325) = 7.148$, p $= 0.008$, R2 $= 0.022$, $R^2_{adj}= 0.019$). This indicated that maternal secondary education was a significant factor in students' academic achievement.

Besides, the first model of the combined internal and external factor model revealed that maternal secondary education level was a significant factor for students' CGPA and

Table 1. Study participants' demographic characteristics (n = 327)

Variables		Frequency (%)
Sex	Female	246 (75.2%)
	Male	81 (24.8%)
Paternal Education	No Formal	16 (4.9%)
	Primary	39 (11.9%)
	Secondary	138 (42.2%)
	Tertiary	134 (41.0%)
Maternal Education	No Formal	15 (4.6%)
	Primary	38 (11.6%)
	Secondary	151 (46.2%)
	Tertiary	123 (37.6%)
Household Income	<RM1000	50 (15.3%)
	RM1000 - RM3000	132 (40.4%)
	RM3001 - RM5000	69 (21.1%)
	>RM5000	76 (23.2%)

Table 2. Summary of results of stepwise multiple regression.

Model			SS	df	MS	F	P-Value	R^2	R^2_{adj}	RMSE
Internal Factor	1	Regression	0.663	1	0.663	6.528	0.011	0.020	0.017	0.319
		Residual	33.026	325	0.102					
		Total	33.689	326						
	2	Regression	1.099	2	0.549	5.462	0.005	0.033	0.027	0.318
		Residual	32.590	324	0.101					
		Total	33.689	326						
External Factor	1	Regression	0.725	1	0.725	7.148	0.008	0.022	0.019	0.318
		Residual	32.964	325	0.101					
		Total	33.689	326						
Internal and External Factor	1	Regression	0.725	1	0.725	7.148	0.008	0.022	0.019	0.318
		Residual	32.964	325	0.101					
		Total	33.689	326						
	2	Regression	1.490	2	0.745	7.497	<0.001	0.044	0.038	0.315
		Residual	32.199	324	0.099					
		Total	33.689	326						

Note. SS: Sum of sequence, MS: Mean Squares, R^2_{adj}: Adjusted R^2

the regression equation for this model was significant ($F(1, 325) = 7.148$, p $= 0.008$, R2 $= 0.022$, $R^2_{adj} = 0.019$). The second model showed that the maternal secondary education together with students' self-esteem were significant factors for students' achievement which reached statistical significance ($F(2, 324) = 7.497$, p < 0.001, R2 $= 0.044$, $R^2_{adj} = 0.038$). Among the three models, the second model of internal and external factor model was the best model since it has a lower value of MSE, RMSE, and higher adjusted R2 as compared to others.

Table 3 shows the non-standardized and standardized regression coefficients. Based on the table, the equation for the internal factor model is shown in Eq. (14) and Eq. (15). The external factor model is shown in Eq. (16), whereas the combination of internal and external factor models are shown in Eq. (17) and Eq. (18).

$$y = 3.143 + 0.010x_{SE} \tag{14}$$

$$y = 3.039 + 0.009x_{SE} + 0.008x_{IQ} \tag{15}$$

$$y = 3.263 + 0.094x_{MS} \tag{16}$$

$$y = 3.263 + 0.094x_{MS} \tag{17}$$

$$y = 3.084 + 0.101x_{MS} + 0.010x_{SE} \tag{18}$$

Table 3. Regression coefficients

Model		Variable	Unstandardized Coefficient (B)	Standard Error	Standardized Coefficient (β)	t	P-Value
Internal Factor	1	Constant	3.143	0.066		47.305	<0.001
		x_{SE}	0.010	0.004	0.140	2.555	0.011
	2	Constant	3.039	0.083		36.614	<0.001
		x_{SE}	0.009	0.004	0.130	2.376	0.018
		x_{IQ}	0.008	0.004	0.114	2.081	0.038
External Factor	1	Constant	3.263	0.024		135.936	<0.001
		x_{MS}	0.094	0.035	0.147	2.674	0.008
Internal and External	1	Constant	3.263	0.024		135.936	<0.001
		x_{MS}	0.094	0.035	0.147	2.674	0.008
	2	Constant	3.084	0.069		44.800	<0.001
		x_{MS}	0.101	0.035	0.157	2.884	0.004
		x_{SE}	0.010	0.004	0.151	2.774	0.006

Table 4. VIF and tolerance value.

Model		Variable	Tolerance	VIF
Internal Factor	1	Constant		
		x_{SE}	1.0	1.0
	2	Constant		
		x_{SE}	0.992	1.008
		x_{IQ}	0.992	1.008
External Factor	1	Constant		
		x_{MS}	1.0	1.0
Internal and External	1	Constant		
		x_{MS}	1.0	1.0
	2	Constant		
		x_{MS}	0.995	1.005
		x_{SE}	0.995	1.005

Table 5. Normality Test for Standardized Residual

Standardized Residual	Kolmogorov-Smirnov		
	Statistic	df	P-Value
Internal Model	0.043	327	0.200
External Model	0.043	327	0.200
Internal and External Model	0.045	327	0.200

3.3   Multicollinearity and Normality Test of the Models

The model's assumption of multicollinearity was evaluated using VIF and tolerance value. VIF value less than 10 and a tolerance value more than 0.1 indicates no multicollinearity issues [37].

According to Table 4, all the VIF and tolerance values were in the acceptable range. As a result, it is possible to infer that the models were free from multicollinearity problems.

Then, the normality test was carried out to check the normality of the residuals. According to Table 5, the Kolmogorov-Smirnov test showed that all the models have a p-value of 0.200 which is greater than 0.05. Therefore, it can be concluded that the standardized residuals are normally distributed.

4   Discussion

The current study's goal was to identify the significant contributing factors to students' educational performance. In order to achieve the study's goal, stepwise multiple regression was used. There are three regression models that have been developed which were the internal factors model, the external factors model, and the combined model of internal and external factors model. The internal factors model generated two models, the first model demonstrated that only self-esteem was a major contributing factor to students' learning outcomes. The second model revealed that both self-esteem and IQ were significant factors affecting learning outcomes. Both of these models indicated that self-esteem and IQ were significant factors contributing to students' achievement in academics.

The external factors model found that maternal secondary education has a significant impact on students' academic achievement. Two models were developed from the combination of internal and external factors model. The first model revealed that only maternal secondary education was a significant factor in students' learning outcomes. Besides, the second model exposed that maternal secondary education together with self-esteem significantly contributed to students' success. Both of these models showed that maternal secondary education and self-esteem were contributing factors to educational achievement. The second model of internal and external factor model was the best model among the others since it had a lower value of MSE, RMSE, and higher adjusted R2.

Based on the findings of this study, students' self-esteem, IQ, and maternal education were significant contributing factors to their high academic achievement. Higher self-esteem will lead to better academic performance. Students who are more self-assured and trust in their abilities will perform better in academics. This finding was consistent with [6, 8], whereby self-esteem has been discovered as one of the significant contributing factors to students' educational outcomes. Furthermore, the findings were in line with [15–18], who discovered that students' intelligence has become one of the relevant factors that lead to higher academic achievement.

Additionally, findings revealed that maternal secondary education was a significant factor in students' achievement as compared to other levels of education. Students whose mothers have a secondary level of education tend to outperform others in terms of academic achievement. This might be because they were highly driven to improve their finances and self-promote further education through scholarships, as the majority of students in this research came from low-income households. This study confirmed the findings of [27], who discovered that maternal education is one of the factors that affect students' learning outcomes.

Nevertheless, this finding was in disagreement with [38, 39] whereby maternal education was found as an insignificant factor in students' educational grades. The current study also revealed that paternal education was not a significant factor contributing to students' performance. It seems that maternal education was important to students' performance since the mother spent more time with the children than the father [38].

The value for R2 and adjusted R2 for all the models were low which means that the model did not achieve a good fit. This illustrates that the factors included in the model did not explain the response variable well. There might be another independent variable that more or might explain students' performance better. However, the result of ANOVA

tests was sufficient enough to support the significance of the models which indicated that academic achievement can be modelled by the tested factors. Besides, it is still possible to make a conclusion since the significance level showed that self-esteem, IQ, and maternal education were statistically significant factors in academic achievement.

The significant coefficients still represent the change in academic achievement for one unit of change in the independent variables (self-esteem, IQ, maternal education). These factors have demonstrated their importance in determining students' academic success because the R2 and adjusted R2 continued to increase when the variables were taken into account, despite the fact that the contribution was small. Moreover, prior studies [28, 40, 41] also reported very low values of R2 and adjusted R2 [28] which revealed that 9.9% of students' performance was explained by conscientiousness, extraversion, and parents' income.

Furthermore, [40] discovered the dimensions of emotional intelligence explained 8.7% of students' achievement and 3% of students' performance was explained by self-esteem instability [41]. It shows that the R2 values of less than 20% are common in various social science and psychology contexts [28, 40–42]. This is due to the fact that the factors in the models are latent variables and do not directly contribute to the estimation of CGPA itself.

Besides, multiple regression has a limitation in considering latent variables where it assumed all variables are observable and have no measurement error [43]. As a result, structural equation modelling should be employed in the future since it allows researchers to include latent variables and measurement errors in the analyses, assisting them in addressing complex relationships [44]. To add, the aim of this study was to identify the significant contributing factors for academic achievement that was represented by the CGPA and not for the purpose to regress the CGPA using the model.

5   Conclusion

The current study's findings indicated that self-esteem, IQ, and maternal education were major contributors to higher academic achievement. As a result, the government, parents, educators, and university administration should collaborate to establish methods or programs that focus on these three factors to improve students' achievement. For future research, it is recommended to employ structural equation modelling to examine the direct and indirect effect of the variables on students' academic achievement. Besides, it is suggested to add more variables that might be affecting students' academic achievement such as study habits, time management, attendance, and many more.

References

1. Maduagwu, B.C., Carew, F.C., Fajonyomi, M.G., Maduagwu, S.M.: Relationship between academic self-esteem and performance in English language and mathematics of primary school pupils. J. Educ. Found. **4**(1), 9–21 (2014)
2. Rahmani, P.: The relationship between self-esteem, achievement goals and academic achievement among the primary school students. Procedia. Soc. Behav. Sci. **29**, 803–808 (2011). https://doi.org/10.1016/j.sbspro.2011.11.308
3. Vishalakshi, K.K., Yeshodhara, K.: Relationship between self-esteem and academic achievement of secondary school students. Indian J. Appl. Res. **1**(12), 83–84 (2011). https://doi.org/10.15373/2249555x/sep2012/29
4. Jenaabadi, H.: Studying the relation between emotional intelligence and self esteem with academic achievement. Proc. – Soc. Behav. Sci. **114**, 203–206 (2014). https://doi.org/10.1016/j.sbspro.2013.12.685
5. Nauli Thaib, E.: Hubungan antara prestasi belajar dengan kecerdasan emosional. J. Ilmiah Didaktika **13**(2), 384–399 (2013). https://doi.org/10.22373/jid.v13i2.485
6. Duru, E., Balkis, M.: Procrastination, self-esteem, academic performance, and well-being: a moderated mediation model. Int. J. Educ. Psychol. **6**(2), 97–119 (2017). https://doi.org/10.17583/ijep.2017.2584
7. Al-Doulat, A.S.: The relationship between self-esteem and academic achievement in the scientific concepts and methods of teaching course among female students of the class-teacher at the University of Jordan. Mod. Appl. Sci. **12**(2), 164–170 (2018). https://doi.org/10.5539/mas.v12n2p164
8. Colquhoun, L.K., Bourne, P.A.: Self-esteem and academic performance of 4th graders in two elementary schools in Kingston and St. Andrew, Jamaica. Asian J. Bus. Manag. **4**(1), 36–57 (2012)
9. Bibi, S., Saqlain, S.: Relationship between emotional intelligence and self-esteem among pakistani university students. Cell Dev. Biol. **6**(4) (2016). https://doi.org/10.4172/2161-0487.1000279
10. Wijekoon, C.N., Amaratunge, H., De Silva, Y., Senanayake, S., Jayawardane, P., Senarath, U.: Emotional intelligence and academic performance of medical undergraduates: a cross-sectional study in a selected university in Sri Lanka. BMC Med. Educ. **17**(176) (2017). https://doi.org/10.1186/s12909-017-1018-9
11. Aghamohammadi, M., Asgari, S.: The relationship between personality characteristics and emotional intelligence and academic performance at the students of medical sciences the Alborz Province. Biomed. Pharmacol. J. **9**(2), 715–722 (2016). https://doi.org/10.13005/bpj/994
12. Suleman, Q., Hussain, I., Syed, M.A., Parveen, R., Lodhi, I.S., Mahmood, Z.: Association between emotional intelligence and academic success among undergraduates: a cross-sectional study in Kust, Pakistan. **14**(7) (2019). https://doi.org/10.1371/journal.pone.0219468
13. Chen, Y.T.: Personality traits, emotional intelligence and academic achievements of university students. Am. J. Applied. Psychol. **4**(3), 39–44 (2015). https://doi.org/10.11648/j.ajap.s.2015040301.17
14. Rahimi, M.: The relationship between emotional intelligence, self-esteem, gender and educational success. **6**, 481–486 (2016). https://doi.org/10.5267/j.msl.2016.5.005
15. Morales-Vives, F., Camps, E., Dueñas, J.M.: Predicting academic achievement in adolescents: the role of maturity, intelligence and personality. Psicothema **32**(1), 84–919 (2020). https://doi.org/10.7334/psicothema2019.262

16. Salimabarkar, A., Ara, A.: Intelligence as a determinant of academic achievement: a comparative study of high achievers and underachievers. Int. J. Humanit. Soc. Sci. (IJHSS) **6**(6), 79–88 (2017)
17. Day, L., Hanson, K., Maltby, J., Proctor, C., Wood, A.: Hope uniquely predicts objective academic achievement above intelligence, personality, and previous academic achievement. J. Res. Pers. **44**(4), 550–553 (2010). https://doi.org/10.1016/j.jrp.2010.05.009
18. Kappe, R., Van Der Flier, H.: Predicting academic success in higher education: what's more important than being smart? J. Psychol. Educ. **27**(4), 605–619 (2012). https://doi.org/10.1007/s10212-011-0099-9
19. Kaur, N., Kaur, A., Kaur, J.: Influence of intelligence quotient on the academic achievement of students. Int. J. Adv. Res. **6**(8), 541–548 (2018). https://doi.org/10.21474/ijar01/7550
20. Marcela, V.: Learning strategy, personality traits and academic achievement of university students. Proc. – Soc. Behav. Sci. **174**, 3473–3478 (2015). https://doi.org/10.1016/j.sbspro.2015.01.1021
21. Geramian, S.M., Mashayekhi, S., Ninggal, M.T.B.H.: The relationship between personality traits of international students and academic achievement. Proc. – Soc. Behav. Sci. **46**, 4374–4379 (2012). https://doi.org/10.1016/j.sbspro.2012.06.257
22. Hazrati-Viari, A., Rad, A.T., Torabi, S.S.: The effect of personality traits on academic performance: the mediating role of academic motivation. Proc. – Soc. Behav. Sci. **32**, 367–371 (2012). https://doi.org/10.1016/j.sbspro.2012.01.055
23. Safdar, G., Shahzada, S.: Ullah: Relationship between students' personality traits and their academic achievement in Khyber Pakhtunkhwa, Pakistan. J. Educ. Soc. Res. **3**(2), 437–444 (2013)
24. Komarraju, M., Karau, S., Schmeck, R.R., Avdic, A.: The Big Five personality traits, learning styles, and academic achievement. Pers. Indiv. Differ. **51**(4), 472–4779 (2011). https://doi.org/10.1016/j.paid.2011.04.019
25. Cazan, A.M., Schiopca, B.A.: Self-directed learning, personality traits and academic achievement. Proc. – Soc. Behav. Sci. **127**, 640–644 (2014). https://doi.org/10.1016/j.sbspro.2014.03.327
26. Farooq, M.S., Chaudhry, H., Shafiq, M., Berhanu, G.: Factors affecting students' quality of academic performance: a case of secondary school level. J. Qual. Technol. Manag. **8**(2) (2011)
27. Ampofo, E.T., Owusu, B.O.: Academic ambition and effort in the public senior high schools. Int. J. Acad. Res. Reflect. **3**(5), 19–35 (2015)
28. Al-Naggar, R.A., Osman, M.T., Ismail, Z., Bobryshev, Y.V., Ali, M.S., Menendez-Gonzalez, M.: Relation between type of personality and academic performance among Malaysian health sciences students. Int. Arch. Med. **8**(182) (2015). https://doi.org/10.3823/1781
29. Krejcie, R.V., Morgan, D.W.: Determine sample size for research actives. J. Educ. Psychol. Meas. **3**, 607–6709 (1970)
30. Rosenberg, M.: Society and the Adolescent Self-Image. Princeton University Press, Princeton (1965)
31. Wong, C.S., Law, K.S.: Wong and Law Emotional Intelligence Scale (WLEIS). Database record, APA PsycTests (2002)
32. Openpsychometrics.org, IQ Test. https://openpsychometrics.org/printable/intelligence-quotient-test.pdf
33. John, O.P., Srivastava, S.: The big-five trait taxonomy: history, measurement, and theoretical perspectives. In: Pervin, L.A., John, O.P. (eds.) Handbook of Personality: Theory and Research, vol. 2, pp. 102–138. Guilford Press, New York (1999)
34. Chowdhury, M.Z.I., Turin, T.C.: Variable selection strategies and its importance in clinical prediction modelling. Family Med. Commun. Health **8**(1) (2020). https://doi.org/10.1136/fmch-2019-000262

35. Pham, H.: A new criterion for model selection. Mathematics **7**(12) (2019). https://doi.org/10.3390/math7121215
36. Ramanathan, R.: Introductory Econometrics with Applications, 3rd edn. Harcourt Brace College (1995)
37. Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E.: Multivariate Data Analysis. Prentice-Hall, Upper Saddle River (2010)
38. Abosede, S.C., Akintola, O.A.: Mothers' employment, marital status and educational level on students' academic achievement in Business Studies. Multidisc. Res. **4**(2), 159–165 (2016)
39. Glawala Amuda, B., Ali, D.G.: Parents' level of education as predictors of academic performance of NCE students of colleges of education in the North-Eastern States of Nigeria. IOSR J. Humanit. Soc. Sci. **21**(2), 41–47 (2016). https://doi.org/10.9790/0837-21224147
40. Yahaya, A., Yahaya, N., Boon, Y., Hashim, S., Lee, G.: The impact of emotional intelligence element on academic achievement. Arch. Des. Sci. **65**(4) (2012)
41. Zeigler-Hill, V., Li, H., Masri, J., Smith, A., Vonk, J., Madson, M.B., Zhang, Q.: Self-esteem instability and academic outcomes in American and Chinese college students. J. Res. Pers. **47**(5), 455–463 (2013). https://doi.org/10.1016/j.jrp.2013.03.010
42. Onditi, A.: Relationship between customer personality, service features and customer loyalty in the banking sector: a survey of banks in Homabay county, Kenya. Int. J. Bus. Soc. Sci. **4**(15), 132–1509 (2013)
43. Akkuş, G.: An evaluationary work on two prevailing research methods: SEM and MR in the context of food tourism. J. Tour. Gastron. Stud. **4**, 27–30 (2016)
44. Nunkoo, R., Ramkissoon, H.: Structural equation modelling and regression analysis in tourism research. Curr. Issues Tour. **15**(8), 777–802 (2011). https://doi.org/10.1080/13683500.2011.641947