Available online at
https://jcrinn.com/
https://crinn.conferencehunter.com/

Journal of Computing Research and Innovation 9(1) 2024

Journal of Computing Research and Innovation

Factor that Affects the Students' Performance in Mathematics Subject using Logistic Regression

Norwaziah Mahmud[1], Nur Syuhada Muhammat Pazil[2*], Nur Syakirah Rosli[3], Siti Hafawati Jamaluddin[4]

[1,3,4]*Mathematical Sciences Studies, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA Perlis Branch, Arau Campus, 02600 Arau, Perlis, Malaysia*
[2] *Mathematical Sciences Studies, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA Jasin Campus, 77300 Merlimau, Melaka, Malaysia*

ARTICLE INFO

Article history:
Received: 8 January 2024
Revised: 5 February 2024
Accepted: 5 February
Online first: 1 March 2024
Published 1 March 2024

Keywords:
Prediction
Academic
Performance
Logistic Regression
Mathematics

DOI:
10.24191/jcrinn.v9i1.394

ABSTRACT

Predicting students' academic performance plays an important role in academics. Mathematics is a science concerned with the logic of shape, quantity, and order. This subject holds a crucial role in the school curriculum. Mathematics is a basic knowledge that students should have the expertise in order for them to score in the other subjects. However, most students find Mathematics a difficult subject, they will have difficulty scoring in this subject. Therefore, this paper aims to determine the factors that affect students' performance in Mathematics subject which is the pre-calculus subject among students of Diploma in Computer Sciences (CS110) in UiTM Cawangan Melaka Kampus Jasin. During the analysis, gender, assessment marks, place of students, time spent studying pre-calculus subject per week, whether the student took additional mathematics in SPM, act as independent variables whereas grade for pre-calculus subject as the dependent variable, were examined. The assessments refer to test 1, test 2, lab assignment, quiz 1, quiz 2 and written assignment. The logistic regression model was applied, and the results showed that the gender, test 2 and quiz 2 are variables that are significant to the model with the *p*-value 0.031,0.014 and 0.03 respectively. When examining the variables influencing the academic performance of CS110 students at UiTM Cawangan Melaka Kampus Jasin, there are certain knowledge gaps and restrictions. It is advised that future studies should collect data from more respondents and keep the question simple but clear in order to get more accurate results.

1. INTRODUCTION

The scientific and technical advancement of nations depends on mathematics. This is due to the fact that knowledge of mathematics is crucial in comprehending other fields, such as engineering, physics, social science, and even arts (Patena & Dinglasan, 2013). Mathematics is a science concerned with the logic of shape, quantity, and order. Mathematics is present in every aspect of real lives. Many students consider

[2*] Corresponding author. *E-mail address*: syuhada467@uitm.edu.my
https://doi.org/10.24191/jcrinn.v9i1

mathematics to be the most tough and difficult subject. Learning mathematics plays a significant role in helping each student develop the skills necessary to become a valuable human resource (Nofriyandi & Andrian, 2022). According to Ashaari et al. (2011), majority of the students find Mathematics to be challenging because they lack knowledge of the topic, its techniques, and its conceptual framework. In addition, Omar et al. (2022) revealed that for a high performing group of students, emotion has been found to be a significant predictor of mathematics anxiety.

Several studies were conducted to reveal the factors that affect students' performance in Mathematics. Iddrisu et al. (2023) discovered that willingness to learn Mathematics, perceptions that Mathematics is a difficult subject, readiness for the use of Mathematics teaching and learning materials available, relationship with Mathematics teachers and attentiveness in Mathematics lessons all affected students' academic performance in Mathematics. It can be concluded that Mathematics achievement is predicted by the qualities of the students. Another study conducted by Kuppusamy and Musa (2021) aims to investigate the six factors that influence International School secondary student's attitude towards their Mathematics' performance. The factors are self-efficacy, self-judgement, seeking-help, self-reaction, Mathematical anxiety, beliefs in utility of Mathematics in real life and teachers' involvement. The result disclosed that, self-efficacy is the attitude characteristic that affects students' performance the most. The results give educators, schools, and other organizations a clearer picture of how to improve teaching and learning methods to raise students' self-efficacy in classrooms. In order to forecast characteristics that affect students' achievement in mathematics, Bakar et al. (2019) used five factors which are difficult problems, steps, understanding, word problem and effort. It was discovered that students' achievement in Mathematics was greatly influenced by difficult problems, steps, and understanding. Furthermore , Rodríguez et al. (2020) revealed that there is positive significant gender differences in Mathematics performance. Similarly, the result from Jaafar et al. (2021) confirm that five factors were significant with students' Mathematics performance which are semester intake, gender, assessment marks, SPM Mathematics grade and SPM Additional Mathematics grade.

While in studying factor that contribute to a students' success in a subject, which was conducted by Farooq et al. (2011),a socioeconomic status (SES), such as a higher level of SES is the best indicator contributing to the quality of a student's achievement. In the same way, Soule (2017) carried out a study to improve prediction techniques regarding the future performance of students in the selected university. The variables that the researcher used in the study are based on pretest, homework, quiz and test score, and attendance. As a result, homework has an almost linear relationship early semester, whereas the mid-semester plot rapidly approaches a success probability of 1. Similarly, Shedriko (2021) conducted a study to predict students' graduation in a subject using the independent variables such as homework, mid-test and final-test. It was revealed that the homework variable is very significant factor in student graduation.

Logistic regression was firstly developed by statistician D.R. Cox in 1958 as a statistical method. Logistic regression is a process of modelling the probability of a discrete outcome given an input variable. It is used to model the probability of a certain class or event, such as pass or fail, win or lose, alive or dead or healthy or sick. Sperandei (2014) stated that logistic regression could be used to obtain the odds ratio in the presence of more than one explanatory variable. Furthermore, it avoids confounding effects by analyzing the association of all the variables.

Logistic regression has also been considered by many analysts to be an important procedure in predictive analytics. Logistic regression can be used for three purposes which are to predict the probability of the outcome or response variable, to categorize outcomes or predictions and to access the odds or risks associated with model predictors. Surveys conducted by Zou et al. (2019) stated that logistic regression has many iterations. It also takes a long time to bring a large amount of data, which is not applicable. Most researchers will use logistic regression as a broad data processing method in terms of binary classification

https://doi.org/10.24191/jcrinn.v9i1

and predictions. Logistic regression mainly focuses on application. Researchers rarely explore deeply the underlying theoretical models and assumptions when applying logistic regression algorithms, so, there will be unreasonable applications.

In recent years, there has been an increasing amount of literature on logistic regression analysis. An example is, one of the applications reviewed by Ramosacaj et al. (2015) in the study of students' performance levels. The results are divided into two categories which are less than 30% credits and more than 30% credits. They calculated the probability of success and failure. The odd ratio is a good indicator that shows the chances of success against failure under specific conditions of the data. Next, null hypothesis (H_0) was made, and then, a test was run to decide whether to accept or reject the (H_0). By using the dependent variable, logistic regression analysis was performed. They assumed that the student with less than 30 credits failed in one or more subjects. The result concluded that the factors that contributed to students' success are gender, types of private or public school and their location or environment.

A similar study was conducted by Adejumo and Adetunji (2013). They applied logistic regression analysis to evaluate the students' performance of Nigerian students. The objectives of the study were to study the factors that contribute to the students' performance. The results indicated that the mode of entry, age at entry, department, and gender of students are the factors that contributed to students' success in academics. Syuhada et al. (2023) used logistic regression analysis to identify the factor influencing students' performance in Statistics subject. The analysis showed that test 2 and final test marks are the variables that affect to the result of the subject.

Logistic regression can also be used in other fields, such as epidemiological studies. Jin (2015) have studied an epidemiological study. The study aims to determine the relationship between bovine tuberculosis (bTB) incidence in cattle herds and potential risk factors (explanatory variables) from 2005 to 2009 using the logit model. Since they have many explanatory variables, which are more than 30, they examined associations between the response variable and each explanatory variable in a univariate analysis using Spearman's rank correlation coefficient first. The correlation among the variables then being tested using Pearson's and Spearman's rank correlation.

Furthermore, a study was carried out to predict fashion trends using runway images. The study used logistic regression presented by Chakraborty et al. (2020). The aim of the study is to predict patterns and outfits based on the images collected from New York Fashion Week Fall/Winter 2019 (NYFW-19). First, they did the analytical method, which is logistic regression. This is to predict the dichotomous or binary dependent variable(s) based on the relationship with predictors or independent dummy variables. Researchers built the flowchart based on their study to predict more precisely. The data was collected through social media, which is Instagram. This application of logistic regression helped the designers to understand the product types, styles and patterns that would be popular in the coming season.

In addition, a study about cucumber cultivars was conducted by Díaz-Pérez et al. (2019) using the logistic regression method. The objective of the study is to create a binary logistic regression method to evaluate and choose cucumber cultivars (Cucumis sativus L) with a longer post-harvest shelf life. The result shows that the cucumber cultivars with a longer shelf life can be selected if it has a simple and multiple binary logistic regression analysis. First, fruit samples were obtained, and a sample was taken. The samples were kept under preservation conditions through the storage period under temperature and relative humidity appropriately. Then, a sub-sample of 50 fruits was taken, and market quality was evaluated individually. Next, binary logistic regression seeks to identify whether a relationship exists between a dependent variable associated with the occurrence or not of an event (dichotomous type) and one or more categorical or continuous independent variables. Then, the regression model was applied to evaluate the influence of storage time on the probability of marketability. Finally, the goodness-of-fit test was applied based on the

https://doi.org/10.24191/jcrinn.v9i1

"Hosmer-Lemeshow goodness-of-fit" statistic. The software that the researchers used in this study were Statgraphics Centurion XVII-X64 and IBM SPSS Statistics Version 23.

There is extensive research to investigate the factors that could contribute to students' success in academic performance. For example, Arora and Saini (2014) have presented a Neural Network model fused with Fuzzy Logic to model the academic profile of students. This study was divided into four sections. The first section explained about the factors that they studied. In the second section, they stated the significance of the study. The third section briefed on how the application used a Fuzzy ARTMAP network and the applicability of neural Fuzzy ARTMAP. Finally, in the last section, they explained and discussed the results and conclusion. At the end of the study, researchers concluded that to improve students' performance, teachers have to play the main role in preparing their lectures based on the level of the students and motivating the students by advising them to focus on their studies to achieve the best results.

A study about predicting students' success using fine-grain clicker data was conducted by Porter et al. (2014). This study aims to clarify the understanding of this phenomenon using in-class clicker questions as a source of students' performance. Data were collected from 12 weeks of CSI offered in 2013 at a large research-intensive university. Students must complete the assignments and sit for a midterm assessment and a final exam. There were steps and process that was summarized in a PI cycle. First and foremost, they had to vote individually on a conceptual question proposed by the instructors. Next, they had to discuss in a group and vote again. Lastly, they had a class-wide discussion. The instructor led a class-wide discussion of relevant concepts and misconceptions. They combined questions across three-week intervals to reduce noise in the dataset. The researchers also studied a correlation between clicker responses and components of the final exam. Then, the correlations were presented in the form of a table. As a result, clicker question performance, particularly in the early weeks of the term, is highly correlated with performance on code-writing questions, multiple-choice questions, and the final exam overall.

Besides, Mahmud et al. (2022) used Multiple Linear Regression (MLR) to analyze the factors that influence students' academic performance during the COVID-19 pandemic. In this case, the hometown areas and hours students spent preparing before class are significantly in affecting the students' CGPA. It has been demonstrated that students who live in rural areas perform better academically than students who live in cities.

Hence, this study will focus on the factors that could affect the performance of Mathematics subjects. The subject involves in this study is pre-calculus (MAT133), which most students in various UiTM programs take. This study selected students from the Diploma in Computer Sciences (CS110) program at UiTM Cawangan Melaka Kampus Jasin because this program often recorded a failure percentage exceeding 25% since June 2019. The failure percentage exceeding 25% is considered high in the UiTM system.

2. METHODOLOGY

2.1 Data Collection Method

This study was conducted among 122 students Diploma in Computer Sciences from UiTM Cawangan Melaka Kampus Jasin which involved all students who took pre-calculus subjects for semester October 2021 – February 2022. A questionnaire was distributed online to the respondents. The questionnaire consists of two sections which are section A and section B. In section A, respondents needed to fill in their information which are gender, place of residence, grade for pre-calculus subject and whether the student took Additional Mathematic during SPM. In section B, there are questions about, assessment marks; test 1, test 2, quiz 1, quiz 2, lab assignment, written assignment and time spent studying pre-calculus subject per week.

https://doi.org/10.24191/jcrinn.v9i1

Table 1. Section in questionnaire

Part	Questions
A	A Demographic Profiles: • Gender • Grade pre-calculus subject • Place of Residence • Took Additional Mathematics during SPM
B	Time spent studying MAT133 per week Assessment Marks: • Test 1 • Test 2 • Quiz 1 • Quiz 2 • Lab Assignment • Written Assignment

2.2 Set of Variables

The study analyzed the factors that affect students' performance in pre-calculus subject by measuring students' grade on ten factors which are gender, place of residence, test 1, test 2, quiz 1, quiz 2, lab assignment, written assignment, time spent studying pre-calculus subject per week and whether the student took additional mathematic during SPM as shown as in Table 2.

Table 2. Set of variables

Variable	Type of variable	Variable Code
Gender	Qualitative (0 = male, 1 = female)	Gender
Place of residence	Qualitative (0 = off campus, 1 = hostel)	Place
Test 1	Quantitative continuous	T1
Test 2	Quantitative continuous	T2
Quiz 1	Quantitative continuous	Q1
Quiz 2	Quantitative continuous	Q2
Lab Assignment	Quantitative continuous	Lab
Written Assignment	Quantitative continuous	Written
Time spent studying MAT133 per week	Quantitative continuous	Time
Took Additional Mathematics in SPM	Qualitative (0 = no, 1 = yes)	SPM

2.3 Binary Logistic Regression

Logistic regression is a technique that is suitable for examining the relationship between a categorical response variable and one or more categorical or continuous predictor variables. In a nutshell, logistic regression will be used if the dependent variable is categorical and binary. There are only two categories of variables in logistic regression. In general, the occurrence of the event is denoted as 1 and its absence as 0 (Jaafar et al., 2021).

The specific form of the logistic regression model is:

$$P_i = \frac{e^{\beta_0+\beta_1 x_1+\beta_2 x_2+.....+\beta_n x_n}}{1+e^{\beta_0+\beta_1 x_1+\beta_2 x_2+.....+\beta_n x_n}} \quad (1)$$

The transformation of the conditional mean P_i logistic function is known as the logit transformation:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0+\beta_1 x_1+\beta_2 x_2+.....+\beta_n x_n \quad (2)$$

https://doi.org/10.24191/jcrinn.v9i1

where P_i is the probability of the outcome of interest or event,

β_0 is the intercept, β_1 ,…, β_n are regression coefficients x_2 ,… x_n are independent variables.

3. RESULT AND DISCUSSION

3.1 Determining the Model Fit

To determine the fit model, the model must be validated using a number of statistical criteria. There are two statistical criteria used which are Omnibus and Hosmer and Lemeshow. (Hosmer et al., 2013)

3.2 Omnibus

H_0: The logistic model is a good fit for the data,
H_1: The logistic model is not a good fit for the data

p-value = 0.428

Decision: Reject H0 since p-value less than 0.05

Conclusion: The model fits the data

3.3 Hosmer and Lomeshow

H_0: The logistic model is not a good fit for the data
H_1: The logistic model is a good fit for the data

p-value = 0.000

Decision: Reject H_0 since p-value less than 0.05

Conclusion: The model fits the data

3.4 Determining the Model Fit

Ten variables were selected to model the students' performance in Mathematics. The coefficient, Wald Statistics, *p*-value and odd ratio for each variable are shown in Table 3.

Table 3. Logistic Regression Model Coefficient

Variables	Estimate Coefficient	Wald Statistics	P-value	Odds Ratio
Constant	-13.580	14.409	.000	.000
Gender	2.264	4.633	.031*	9.624
Place	-.707	.280	.597	.493
T1	.101	.919	.338	1.107
T2	.213	6.022	.014*	1.238
Q1	.012	.020	.888	1.012
Q2	.572	8.902	.003*	1.771
Lab	.335	3.784	.052	1.399
Written	.056	.847	.358	1.058
Time	-.160	2.641	.104	.852
SPM	.538	.388	.533	1.713

https://doi.org/10.24191/jcrinn.v9i1

Table 3 shows that only three variables are significant which are Gender (Sig = 0.031, $p < 0.05$), T2 (Sig = 0.014, $p < 0.05$) and Q2 (Sig = 0.003, $p < 0.05$) since p-value is less than alpha=0.05, while the other seven variables are not significant to the model. The estimated logit model for full model is as follows:

$$\begin{aligned}\text{Logit}(p) = &-13.580 + 2.264\text{Gender} - 0.707\text{Place} + 0.101\text{T1} + 0.213\text{T2} + 0.012\text{Ql} \\ &+ 0.572\text{Q2} + 0.335\text{Lab} + 0.056\text{Written} - 0.160\text{Time} + 0.538\text{SPM}\end{aligned} \tag{3}$$

Table 3 displays the value of the odd ratio for variables. The odd ratio for first significant variable which is 9.624 for gender. Therefore, this value indicates that most of female students are approximately 9.6 times more likely to pass examination compared to male students, while for T2, the result shows that the value of 1.238 which means that for every one-mark increase in test 2, the odds of passing the examination will increase by 1.238. This indicates that the chance of students was taking the test 2 and getting good score is 1.238 times higher than the students who taking the exam but get bad score.

The last significant variable which is Q2 produced the value of an odd ratio of 1.771 which means that for every one-mark increase in quiz 2, the odds of passing the examination will increase 1.771 This explains that the probability of students who taking quiz 2 and get good score is 1.771 times higher than the students was taking the quiz 2 but get a bad score.

Table 3 also shows the result of Wald Statistics. The value of Wald Statistics for gender (4.633), T2 (6.022) and Q2 (8.902) are more than $\chi^2_{(0.05,1)}$ =3.841. This indicates that, there is a significant effect between the independent variable (Gender, Test 2 and Quiz 2) and grade for pre-calculus subject. Therefore, the best model using Binary Logistic Model is

$$\ln\left(\frac{\text{P}_\text{i}}{1-\text{P}_\text{i}}\right) = -13.580 + 2.264\text{Gender} + 0.213\text{T2} + 0.572\text{Q2} \tag{4}$$

Table 4. Classification table

		Predicted		Percentage corrects
		Fail	Pass	
Observed	Fail	23	7	76.7
	Pass	5	87	94.6
	Overall Percentage			90.2

Table 4 shows the result comparing the outcome predicted using the proposed Binary Logistic Regression Model with the actual data outcome. The data accuracy was 90.2%, which is more than the cut-off point of 50%, which shows that the model possesses good predictive efficiency.

4. CONCLUSION

To achieve the objective of the study, which is to determine the factors that affect students' performance in Mathematics subject, gender, the grade for MAT133, place of residence, status whether the student took Additional Mathematics during SPM, time that students spent studying for the subject and the assessments were analysed using logistic regression analysis. The assessments refer to test 1, test 2, lab assignment, quiz 1, quiz 2 and written assignment. From the results, it is shown that the variables that are significant are gender, test 2 and quiz 2. Gender had significantly influence in mathematical performance hence this fitted

https://doi.org/10.24191/jcrinn.v9i1

with Jaafar et al. (2021) and Rodríguez et al. (2020) who have stated that there is significant difference between male and female in terms of their success in Mathematics.

Findings regarding the other variables such as place of residence, status whether the student took additional mathematics during SPM, test 1, lab assignment, quiz 1, and written assignment tend to be insignificant might be because students had to study online or online distance learning (ODL). In addition, students had different situations and problems at home. Sometimes, the assessment does not affect much in their result because some students tend to copy others without understanding them. Thus, they will have difficulties with their final assessment.

In order to increase their students' sense of mastery and self-efficacy, lecturers should assign them more homework and discuss the answer together in class. Lecturers must also make sure that the students do the exercise given, regardless of their gender. Mathematics teaches students to think creatively and critically. Therefore, lecturers can try to develop critical thinking skill while teaching to train the students to think creatively. Collaboration among educators can improve student learning. When examining the variables influencing the academic performance of CS110 students in UiTM Cawangan Melaka Kampus Jasin, there are certain knowledge gaps and restrictions. It is advised that future studies to collect data from more respondents and keep the question simple but clear in order to get more accurate results. To get more precise result, the future research should collect the data from equal number of male and female students.

5. ACKNOWLEDGEMENTS/FUNDING

The authors would like to thank to the students of Universiti Teknologi MARA Cawangan Melaka Kampus Jasin who participated in this study. The authors would also like to express gratitude to the reviewers for their insightful comments and ideas.

6. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

7. AUTHORS' CONTRIBUTIONS

Syuhada carried out the research, wrote and revised the article. Syakirah conceptualised the central research idea and provided the theoretical framework. Waziah and Hafawati designed the research, supervised research progress; anchored the review, revisions and approved the article submission.

8. REFERENCES

Adejumo, A. O., & Adetunji, A. A. (2013). Application of ordinal logistic regression in the study of students' performance. *Mathematical Theory and Modeling*, *3*(11), 10 - 20.

Arora, N., & Saini, J. R. (2014). Predicting student academic performance using fuzzy ARTMAP network. *International Journal of Advances in Engineering Science and Technology*, *187*(September 2015).

Ashaari, N. S., Judi, H. M., Mohamed, H., & Tengku Wook, T. M. (2011). Student's attitude towards statistics course. *Procedia - Social and Behavioral Sciences*, *18*. https://doi.org/10.1016/j.sbspro.2011.05.041

Bakar, S. A., Ayub, A. F. M., Gopal, K., & Salim, N. R. (2019). The influence of students' beliefs on mathematical problem solving towards mathematics achievement among Malaysian matriculation students. *Universal Journal of Educational Research*, *7*(10). https://doi.org/10.13189/ujer.2019.071025

Chakraborty, S., Hoque, S. M. A., & Kabir, S. M. F. (2020). Predicting fashion trend using runway images: application of logistic regression in trend forecasting. *International Journal of Fashion Design, Technology and Education*, *13*(3). https://doi.org/10.1080/17543266.2020.1829096

Díaz-Pérez, M., Carreño-Ortega, Á., Salinas-Andújar, J. A., & Callejón-Ferre, Á. J. (2019). Application of logistic regression models for the marketability of cucumber cultivars. *Agronomy*, *9*(1). https://doi.org/10.3390/agronomy9010017

Farooq, M. S., Chaudhry, a H., Shafiq, M., & Berhanu, G. (2011). Factors affecting students' quality of academic performance: A case of secondary school level. *Journal of Quality and Technology Management*, *VII*(II).

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression*. John Wiley & Sons. http://search.lib.virginia.edu/catalog/ocn830163779

Iddrisu, A. B., Bornaa, C. S., Alagbela, A. A., Kwakye, D. O., Gariba, A., Ahusah, E. T.-W., & Badger, T. N. A. (2023). Students' characteristics and academic performance in Mathematics. *Journal of Education, Society and Behavioural Science*. https://doi.org/10.9734/jesbs/2023/v36i31214

Jaafar, Z., Ali, R., Ahmad, S. N. D., Ruslan, S. Z. M., & Othman, N. (2021). Logistic regression in analyzing the determinants of university students' mathematics performance. *Mathematical Sciences and Informatics Journal*. https://doi.org/10.24191/mij.v2i2.14977

Jin, R. (2015). Application of logistic regression model in an epidemiological study. *Science Journal of Applied Mathematics and Statistics*, *3*(5). https://doi.org/10.11648/j.sjams.20150305.12

Kuppusamy, S., & Musa, M. (2021). Investigating international school secondary students ' attitude towards Mathematics. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *11*(2), 122–130.

Mahmud, N., Muhammat Pazil, N. S., & Azman, N. A. N. (2022). The significant factors affecting students' academic performance in online class: Multiple linear regression approach. *Jurnal Intelek*, *17*(2), 1–11. https://doi.org/10.24191/ji.v17i2.17896

Nofriyandi, & Andrian, D. (2022). Factors that affect students' mathematics performance at higher education in Riau province during the Covid-19 pandemic. *Infinity Journal*. https://doi.org/10.22460/infinity.v11i2.p367-380

Omar, S. H., Aris, S. R. S., & Hoon, T. S. (2022). Mathematics anxiety and its relationship with mathematics achievement among secondary school students. *Asian Journal of University Education*, *18*(4), 863–878. https://doi.org/10.24191/ajue.v18i4.19992

Patena, A. D. C., & Dinglasan, B. (2013). Students performance on departmental examination: Basis for math intervention program. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2276044

Porter, L., Zingaro, D., & Lister, R. (2014). Predicting student success using fine grain clicker data. ICER 10th Annual International Conference on International Computing Education Research (pp.51-58).

ACM. https://doi.org/10.1145/2632320.2632354

Ramosacaj, M., Hasani, V., & Dumi, A. (2015). Application of logistic regression in the study of students' performance level (case study of Vlora University). *Journal of Educational and Social Research*. https://doi.org/10.5901/jesr.2015.v5n3p239

Rodríguez, S., Regueiro, B., Piñeiro, I., Estévez, I., & Valle, A. (2020). Gender Differences in Mathematics Motivation: Differential Effects on Performance in Primary Education. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2019.03050

Shedriko. (2021). Binary logistic regression in determining affecting factors student graduation in a subject. *Jurnal Teknologi & Open Source*, *4*(1), 114–120. https://doi.org/10.36378/jtos.v4i1.1401

Soule, P. (2017). *Predicting student success : A logistic regression analysis of data from multiple SIU-C courses*. *Fall*, 1–24.

Sperandei, S. (2014). Understanding logistic regression analysis. *Biochemia Medica*, *24*(1). https://doi.org/10.11613/BM.2014.003

Syuhada, N., Pazil, M., Mahmud, N., Baharom, N., & Hafawati, S. (2023). Logistic regression in determining affecting factors student success in an introductory statistics subject. *Jurnal Intelek*, *18*(1), 9–16. https://doi.org/https://doi.org/10.24191/ji.v18i1.20133

Zou, X., Hu, Y., Tian, Z., & Shen, K. (2019). Logistic regression model optimization and case analysis. 7th IEEE 7th International Conference on Computer Science and Network Technology, ICCSNT 2019 (pp.135-139). IEEE Xplore. https://doi.org/10.1109/ICCSNT47585.2019.8962457