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**About**

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## TABLE OF CONTENTS

INSIGHT JOURNAL Volume 4
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eISSN 2600-8564

# Factors Contributing to Mathematics Performance of UiTM Johor Students

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## Abstract

Some Mathematics courses offered by the Faculty of Computer Science and Mathematics (FSKM), University Technology MARA (UiTM) Johor, such as Pre-Calculus (MAT133), Calculus I (MAT183) and Calculus II (MAT233), have been identified as high failure rate courses for recent semesters. As considered by the top management of UiTM Johor, a high failure rate course is a course with more than 25% failure rate among the students who enrolled in the course. The performance of students in these Mathematics courses is a priority to the university management as it aims to produce quality students that can graduate on time. Thus, this study investigates the factors that contribute to the students' Mathematics performance at UiTM Johor. A set of questionnaire was distributed to all students who enrolled in these courses. Descriptive analysis was conducted to analyse the demographic background of the respondents. The main analysis used Logistic Linear Regression to find out the most significant factors contributing to Mathematics performance. From the findings, SPM Additional Mathematics grades and class size were found to have significant influence on Mathematics performance of the students.

**Keywords:** Mathematics performance, SPM Mathematics grades, SPM Additional Mathematics grades, class size, extracurricular activities, English proficiency**.**

## 1. Introduction

Mathematics is a foundation knowledge that is vital to everyone's life as it helps one to have

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
**eISSN 2600-8564**

better reasoning abilities. Therefore, Mathematics is a compulsory subject in both primary and secondary schools in Malaysia. The tertiary education also offers specific type of Mathematics courses according to the field of studies. In the Faculty of Computer and Mathematical Sciences (FSKM), Universiti Teknologi MARA (UiTM) Johor, it is compulsory for the students to pass a pre-requisite course which is Pre-Calculus (MAT133) in order to enroll in the second level of Calculus course which is Calculus I (MAT183). It is also compulsory for them to pass MAT183 in order to enroll the third level of Calculus course which is Calculus II (MAT233). In order to graduate on time, students should pass these three courses within a reasonable period of time. Despite the important role of the Calculus courses, there has always been poor performance in these courses. According to the Lecturers in Charge (LICs) of these courses, MAT133, MAT183 and MAT233 courses have been identified as high failure rate courses for recent semesters. As considered by the top management of UiTM Johor, a high failure rate course is a course with more than 25% failure rate among the students who enrolled in the course. The performance of students in these Mathematics courses is a priority to the university management as it aims to produce quality students that can graduate on time. Thus, this study investigated the factors that contribute to the students' Mathematics performance at UiTM Johor.

### 1.1 Research Objectives

The research objectives for this study are:

i. To identify the significant factors that affect the students' Mathematics performance.
ii. To generate a model based on the factors that affect the students' Mathematics performance.

### 1.2 Research Questions

Based on the research objectives, this research was conducted to answer the following questions:

i. Do factors like SPM Mathematics grades, SPM Additional Mathematics grades, class size, extracurricular activities and English proficiency affect the student's mathematics performance?

ii. What is the model that represents the students' Mathematics performance?

### 1.3 Research Significance

This study gives useful benefits to the faculty, lecturers and other researchers. The benefits are:

i. To the faculty: The findings of this research could give the inputs for the faculty to determine the university requirement for Diploma entries or entries for higher level of study.

ii. To lecturers: The findings of this research could explain several aspects which should be considered by the lecturers to improve the existing mathematics courses.

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
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iii. To researchers: There is lack of research focusing on extracurricular activities and English proficiency to determine students' Mathematic performance. As such, this study will contribute knowledge or ideas to researchers to conduct further studies on this issue

### 1.4 Research Hypotheses

Based on the research question discussed earlier, the five hypotheses to be tested are:

i. SPM Mathematics grades contribute significantly to students' Mathematics performance.
ii. SPM Additional Mathematics grades contribute significantly to students' Mathematics performance.
iii. Class size contributes significantly to students' Mathematics performance.
iv. Extracurricular activities contribute significantly to students' Mathematics performance.
v. English proficiency contributes significantly to students' Mathematics performance.

### 1.5 Limitation of study

There are several limitations throughout of this study.

i. This study only focused on students ar UiTM Johor. Thus, it does not represent the whole population of universities in Malaysia.
ii. Not many local journals or researches – variables used might not be suitable in Malaysia.
iii. In this research, only student factor which comprises the five independent variables were considered. Thus, in other research, other factors such as teacher factor and environmental factor that include family, friends and facilities should be included to study students' Mathematics performance.
iv. This study only focus on Pre-Calculus (MAT133) achievement since this is the first level of the mathematics courses. For further research, other mathematics course achievements which also have high failure rate such as Calculus 1 (MAT183) and Calculus II (MAT233) can be discussed.

### 1.6 Theoretical framework

Figure 1 shows the theoretical framework of the study. It shows the linkage between different factors in students' Mathematics performance as dependent variable is related to the independent variables which are SPM Mathematics grades, SPM Additional Mathematics grades, class size, extracurricular activities and English proficienc.

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
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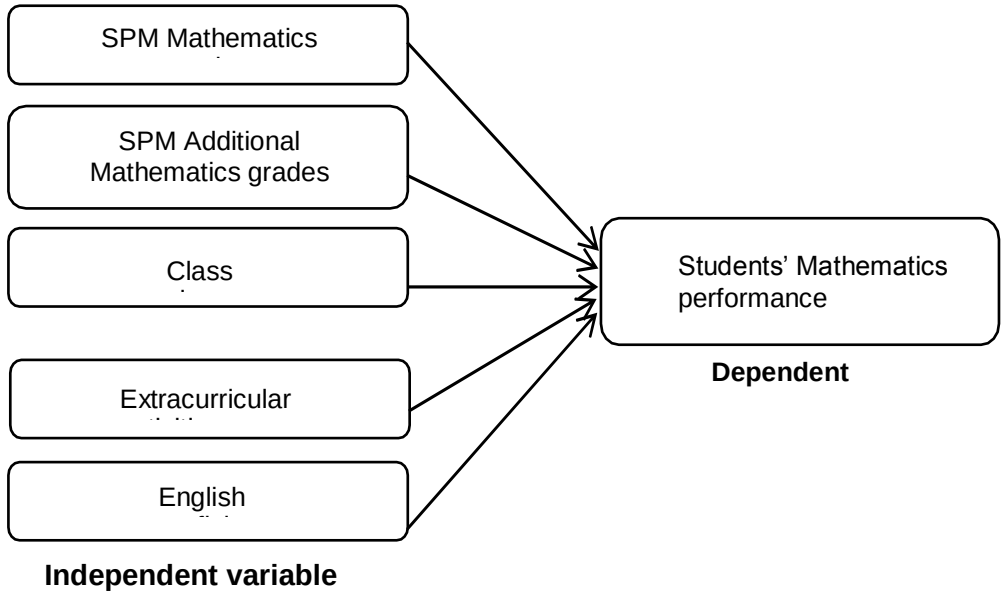


**Figure 1: Theoretical Framework**

## 2. Literature Review

The high failure rate in Mathematics courses is influenced by many factors such as teacher factor, student factor and environmental factor (Suan, 2014). Therefore, there are many factors that could affect the Mathematics performance of students of UiTM Johor. Thus, this research is conducted to help the university management to identify whether the factors of classroom settings, basic Mathematics knowledge, English proficiency and participation in extracurricular activities contribute to the students' Mathematics performance.

### 2.1 Class Size

Jarvis (2002) conducted a research to look at the impact of class setting towards Mathematics performance. From the study, it was found that class size is not a significant factor toward Mathematics performance but the teacher-size interaction effect is weakly significant. On the other hand, Finn and Achiles (1990) found that in the early primary grades, small classes perform better in reading and mathematics compared to the larger classes. Referring to Blatchford (2009), class size had been determined as one of the contributing factors of achievement in both literacy and Mathematics.

### 2.2 SPM Mathematics and Additional Mathematics Grades

Many researches acknowledged the importance of basic Mathematics knowledge in high school in order to understand the new mathematics course offered in higher institution level. According to Yudariah and Roselainy (1997), students who did not performed in the first year mathematics courses in the university level are among the ones who did poorly in their Sijil Pelajaran Malaysia (SPM) Additional Mathematics or did not take the subject at all. Moreover, Tang et.al (2009) found SPM Mathematics grades as one of the contributing factors of all

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**Published by UiTM Cawangan Johor, Malaysia**
**eISSN 2600-8564**

underachievements in Mathematics courses. In addition, Gynnild et al. (2005) revealed that one of the three major reasons students fail in Calculus courses is because of lack of basic skills and knowledge in Mathematics.

### 2.3 SPM English Grade

There is lack of research which studied English proficiency among the students as a contributing factor for underachievement in Mathematics courses. However, the findings found by Junaidi and Mohd (2010) in their studincome proved that during the period of the implementation of teaching and learning Science and Mathematics subjects in English especially in the rural vernacular schools, the achievements in Science and Mathematics subjects declined in the consecutive years. Since the medium of language in UiTM is English, the achievement of the students in Mathematics course may also be affected by the proficiencies in English among the students. Research conducted by Sahragard et al. (2011) also suggested that the students who scored higher on the English language proficiency test had better GPA scores. Al-Haddad et al. (2004) revealed that there exists a relationship between English proficiency and accounting students' academic performance in the case of limited English proficient students.

### 2.4 Extracurricular activities

Extracurricular activities play an important role in determining students' mathematic performance. According to Daniyal et al. (2012), it is found that co-curricular activities improve the academic performance of students. Moreover, Stephens and Schaben (2002) also found that co-curricular activities have positive impact on Grade Point Average (GPA) in which students who actively contribute in the co- curricular activities are more likely to have a GPA of 3.0 or more as compared to those who are not involved in co-curricular activities. Darling et al. (2005) also found the association between the involvement in co-curricular activities and the enhancement in the performance of the students in their academics. Interestingly, Marsh and Kleitman (2002) revealed that the more you spend time in leisure activities the poorer academic performance and poorer working habits are developed, while the more time you spend in formal activities like sports, debate and drama activities, the better grades you get in your studies.

Thus, this research discusses the students' Mathematic performance according to the five factors which are SPM Additional Mathematics grades, SPM Mathematics grades, SPM English grades, class size, and extracurricular activities. Specifically, this study describes the performance in Pre-Calculus course (MAT133) among the students of the Faculty of Computer and Mathematical Sciences. This study gives valuable inputs to the faculty and also the lecturers to assist the students to pass and simultaneously get good grades in the Mathematics courses.

## 3. Methodology

This section discusses some general information about the nature of study and the statistical method applied in running the analysis to accomplish the objectives of this study. Brief explanations on these methods are discussed in this section.

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
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### 3.1 Research Design

This study was conducted using a quantitative approach. The population was Semester 1 diploma students in Mathematical Sciences (CS143) and diploma students in Computer Sciences (CS110) who enrolled in MAT 133 course at UiTM Johor. 253 students in the population have been selected according to their registered course groups. Next, Ordinal Linear Regression was employed to find the best model which represents the students' Mathematics performance at UiTM Johor.

### 3.2 Instrument

For this study, a survey method was used to collect data. A self-administered questionnaire was distributed to the respondents to collect responses within a short period of time (Sekaran & Bougie, 2013). The questionnaire was divided into two parts that are Section 1 for questions on demographic background of the respondents and Section 2 for questions to measure the students' Mathematics performance.

### 3.3 Data analysis method

#### 3.3.1 Descriptive Analysis

As initial steps of analysis, the descriptive measure of the data was carried out to describe basic features of the data for the demographic background of the respondents.

#### 3.3.2 Logistic Regression

In this study, a logistic regression was used to analyse the related factors to the respondents' performance in Pre-Calculus course (MAT133). A logistic regression model was used because the dependent variable has two categories that are good and poor performance in MAT133. The independent variables are SPM Additional Mathematics grades, SPM Mathematics grades, SPM English grades, class size, and extracurricular activities.

For a binary dependent variable, y logistic regression model can be used to study the effect of the categorical independent variables, x. In this model, the dependent variable has two categories and with a set of independent variables. The simple form of logistic regression model or logit with a single independent variable can be expressed as:

$$\text{logit}[\pi(x)] = \log\left(\frac{p}{1-p}\right) = \alpha + \beta x$$

where $p$ is the 'success' probability of y at value of x. $\beta$ denotes whether $p$ is increasing or decreasing as x increases. Logit or log of odds is used to measure the chance that an event will occur. In other words, it is the probability that success will occur divided by the probability

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
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that success will not occur. The logit of the multiple regression with a collection of m independent variables $x_1, x_2, ..., x_m$ is given by

$$\text{logit}[p] = \alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_m x_m$$

where $\beta$, indicates the coefficient of i independent variables.

### 3.3.3 Odds Ratio

Odd is the ratio of the probability that an event of interest occurs to the probability that it does not occur. The odd can be computed by using the following formula:

$$odd = \frac{P(X)}{1 - P(X)} \quad \text{where} \quad P(X) = \text{probability of an event will occur}$$

Odds ratio is a measure of strength of association between an exposure and an outcome. The odds ratio is the odds that an outcome will occur given a particular exposure.

The ratio of odds of event A to the event B can be computed by using the following formula:

$$\text{odd ratio} = \frac{odd(A)}{odd\ B} = \exp(\beta)$$

## 3.4 Model Evaluation Criteria

In logistic regression model, there are five criteria of model evaluation which consists of Omnimbus Test of Model Coefficient, Hosmer and Lemeshow Test, Predictive Efficiency Model, Wald Statistics and Cox and Snell R2 and Nagelkerke R2. The used of each test will be discussed in the next section.

### 3.4.1 Omnimbus Test of Model Coefficient

Omnimbus test is used to test whether the explained variance in a data set is significantly greater than the unexplained variance. The test is a likelihood ratio chi-square test of the current model versus the null model. The significance value of less than 0.05 of the test indicates that the current model outperforms the null model.

### 3.4.2 Hosmer and Lemeshow Test

The Hosmer and Lemeshow test is a statistical test for goodness of fit for the logistic regression. This test tells how well a set of data fits the model. Specifically, the test calculates if the observed event rates match the expected event rates in population subgroups. Like most of goodness fit test, the significance value of less than 0.05 means that the model is a poor fit.

### 3.4.3 Predictive Efficiency Model

Another way of evaluating the fit of logistic regression model is by using Classification Table.

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
**eISSN 2600-8564**

The Classification Table describes the proportion of cases that have managed to figure out correctly. It also describes how many of the cases where observed values of the dependent variable were 1 or 0 respectively have been correctly predicted. Overall percentage equal or more than 70% indicates that it is a good predictive efficiency. Besides using overall percentage to evaluate the predictive model efficiency, sensitivity and specificity can also be used. Sensitivity indicates the percentage of students who pass this subject ant the model is going to predict which student will pass this subject. While specificity is the percentage who actually fail and the model is able to predict which student will fail the subject.

### 3.4.4 Wald Statistics

Wald test is used to determine whether a certain predictor variable is significant or not. The Wald test statistics is the ratio of the square of the regression coefficient to the square of the standard error of the respective predictor and is asymptotically distributed as a chi-square distribution. The easiest way to assess Wald test, if significance values is less than $\alpha = 0.05$, thus accepts the alternative hypothesis as the variable make a significant contribution.

### 3.4.5 Cox and Snell R2 and Nagelkerke R2

The use of this method is to provide an indication of the amount of variation in outcome variable explained by the model and can be thought of as a measure of how poorly the model fits such as lack of fit between observed and predicted values. There are two modified versions of this method, one developed by Cox and Snell R-square and the other developed by Nagelkerke R-square. The Cox and Snell R-square has an upper bound that is less than 1.0. Meanwhile, Nagelkerke R-square range is from 0 to 1 which is a more reliable measure of the relationship. Nagelkerke R-square will be higher than Cox and Snell measure.

## 4. Results and Discussion

This section discusses the results and explanation on the research findings. Data are analysed in order to obtain the factors contributing to students' mathematics performance. A number of tests were conducted to evaluate the model.

### 4.1 Descriptive Analysis

The percentage of respondents based on gender and programme is as follows:

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
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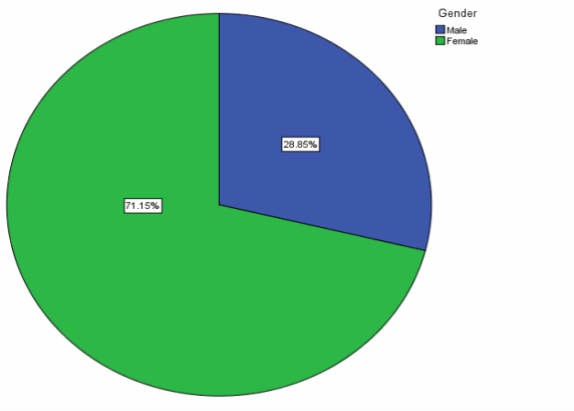


**Figure 1**: Percentage of Respondents Based on Gender

71.15% of the respondents were female while another 28.85% of the respondents were male students.

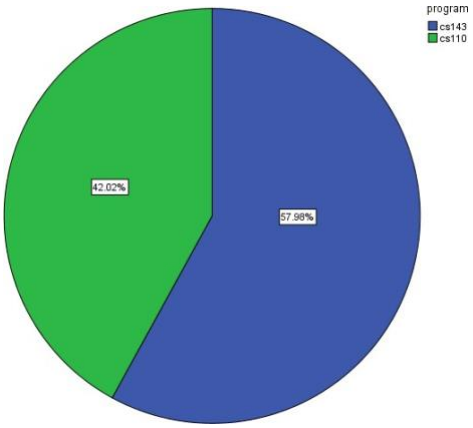


**Figure 2** : Percentage of Respondents Based on Programme

57.98% of the respondents were from CS143 programme while another 42.02% of the respondents were from CS110 programme.

**Table 1: Description of Variables**

| Variable name | Variable Type | Description of code |
|---|---|---|
| Mathematics performance | Ordinal | 0 = fail<br>1 = pass<br>(A+ to C indicate as pass meanwhile C- and below denote fail. |
| SPM Mathematics grades, SPM Additional Mathematics grades and SPM English grades | Ordinal | 0 = distinction (A+ to A-<br>) 1 = credit (B+ to C)<br>2 = pass (D and<br>E) 3 = fail (G) |
| Class size | Ordinal | 0 = 15 or less (small)<br>1 = 16 – 25 (medium)<br>2 = 26 -35 (big)<br>3 = 36 or more (very<br>big) |
| Extracurricular activities | nominal | 0 = yes<br>1 = no |

## 4.2 Factors Contributing to Mathematics Performance

### 4.2.1 Logistic Regression Model

| Variabe | Estimate coefficient | p-value |
|---|---|---|
| Constant | -3.491 | 0.002 |
| SPM_AMath Credit | -2.077 | 0.060 |
| SPM_AMath Pass | -1.324 | 0.006 |
| SPM_English Distinction | 0.169 | 0.727 |
| Class_Size Medium | -16.437 | 0.999 |
| Class_Size Large | 3.568 | 0.001 |
| Extra_Curricular (No) | -0.616 | 0.203 |

Estimated Model:

Log it [ Z = 1] = -3.491 -2.077 SPM_AMath Credit -1.324SPM_AMath Pass + 0.169 SPM_English Distinction -16.437 Class_Size Medium +3.568 Class_Size Large - 0.616 Extra_Curricular (No)

### 4.2.2 Odds Ratio

| Variable | Odd Ratio |
|---|---|
| SPM_AMath Credit | 0.125 |
| SPM_AMath Pass | 0.266 |
| SPM_English Credit | 1.184 |
| Class_Size Medium | 0 |
| Class_Size Large | 35.446 |
| Extra_Curricular (No) | 0.540 |

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Based on odds ratio value in the table above, it can be said that the students with distinction are 0.125 times more likely than those with credit SPM Additional Mathematics to pass MAT133. Besides that, the students with distinction are 1.184 times more likely than those with credit SPM English to pass MAT133. The odds ratio of students who are in medium size class is 35.446 times more likely to pass MAT133 than those who in the large size class. The odds ratio of students who join extracurricular activities is 0.540 times more likely to pass MAT133 than those who do not involve in extracurricular activities.

### 4.2.3 Omnimbus Test of Model Coefficient

| | |
|---|---|
| p-value | 0.000 |

Based on the result, it can be concluded that the information from the independent variables allows for better prediction of the factors contributing to the mathematics performance.

### 4.2.4 Hosmer and Lemeshow Test

| | |
|---|---|
| p-value | 0.597 |

The Hosmer and Lameshow tests the null hypothesis that the data fits the model. The result of the Hosmer and Lemeshow Test shows that we failed to reject null hypothesis. Thus, it suggests that the logistic regression model is good fit for the data since p-value is >0.05.

### 4.2.5 Predictive Efficiency Model

| Sensitivity | Specificity | Overall percentage |
|---|---|---|
| 97.8 | 22.2 | 89.7 |

As can be seen in the above table, overall accuracy of the model to predict the factor contributes to mathematics performance is a good predictive efficiency since the overall percentage of the model is 89.7%. While the sensitivity is given by 97.8% , the specificity is 22.2%.

### 4.2.6 Wald Statistics

Wald statistics shows the statistical significant of the predictor variable. From the table below, it can be concluded that students with credit SPM Additional Mathematics and study in large classroom size significantly influence the students to perform well in MAT133 since the p-values are <0.05.

| Variable | Estimate coefficient | p-value |
|---|---|---|
| SPM_AMath Credit | 7.620 | .006 |
| SPM_AMath Pass | 3.529 | .060 |
| SPM_English Distinction | 0.122 | .727 |
| Class_Size Medium | 0 | .999 |
| Class_Size Large | 11.870 | .001 |
| Extra_Curricular (No) | 1.624 | .203 |

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### 4.2.7 Cox and Snell R2 and Nagelkerke R2

It can be seen from the table below that Cox and Snell R squared is 0.19 and Nagekerke R squared is 0.386. Hence, it can be said that both R squared values indicate that the total variation of the factors contributed to MAT133 performance is about 19% and 38.6% explained by all factors included in the model.

| Cox and Snell R2 | Nagelkerke R2 |
|---|---|
| 0.190 | 0.386 |

## 5. Literature Review

The factors that contribute to students to pass MAT133 course are good result in SPM Additional Mathematics and class size of not more than 35 students. This result was consistent with research by Tang et.al (2009). Thus, it is recommended that a strong grade in SPM Additional Mathematics should be one of the eligibility requirements for future Science-based student intake. Having only SPM Mathematics background is not enough for Science-based students to survive in advanced Mathematics of tertiary education. The top management of the faculty should also be concerned on class size where the class size should be not so large. This is important because students taking MAT133 are in transition period from school to university and may fail to cope in large class size. Meanwhile, the other two factors, English proficiency and extracurricular activities, seem to not be significant. Future research can be carried out for all levels of students which consist of students who have taken the second and the third level of Calculus course. Additionally, a larger sample size and other factors which are not studied in this research also should be considered.

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