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An Analysis on Diploma Students' Performance in Mathematics using Chi-Square Test

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ABSTRACT

Mathematics is a science that studies the logic of shapes, numbers, and orders. This is one of the most crucial subjects in the school curriculum. Mathematics is a fundamental skill that students must learn in order to succeed in other subjects. Students have difficulty in understanding mathematical problems, which affects problem-solving process. Most students find Mathematics is difficult, thus they will struggle to score well in this subject. This study focused on the factors that affect the performance in Mathematics subjects and also to identify the relationship between the factors that affect the performance based on the students' grade in Mathematics. This paper focused the Pre-Calculus subject among 122 students of Diploma in Computer Sciences in UiTM Melaka Branch, Jasin Campus. A set of questionnaires was distributed to the students consist of their demographic profile, assessment marks, time spent studying per week, challenges in learning the subject and feedback on the mathematics' lecturer. The results were analyzed using SPSS and the descriptive statistics of the collected data were presented in charts and percentages. It is shown that, majority of students struggle memorizing facts, methods, and equations, which is followed by analyzing theories, concepts, or ideas, and applying what they have learned in a practical situation. The Chi-Square test was used to analyze the relationship between factors influencing their performance based on the grade and the results showed that gender and place of residence factors directly affect the performance of students in Pre -Calculus subject.

1 INTRODUCTION

Mathematics is a branch of knowledge that allows people to get the notion of patterns, establish the relationship between variables and predict certain phenomena or circumstances with reasoning [1]. 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 [2]. Mathematics is a science concerned with the logic of shapes, quantities, and orders. Mathematics is present in every aspect of real life. Many students consider Mathematics to be the toughest and most difficult subject. According to [3], majority students find Mathematics to be challenging because they lack knowledge of the topic, its techniques, and its conceptual framework. In addition, [4] revealed that for a high performing group of students, emotion has been found to be a significant predictor of Mathematics anxiety.

Education is a human's need throughout life. Without education, it will be difficult for human growth as education plays an important role in one's life. According to [5], the purpose of Mathematics education is surely to make students actualize learning at the highest level. However, the fact that most of the students experience difficulties while they actualize learning is considered a reality of life. That is the importance of Mathematics education, so that the knowledge gained will make it easier for them to apply it into their daily lives. Furthermore, [6] indicated that students struggle with problem solving. Data obtained from interviews with teachers in the field of Mathematics studies revealed that;1) students have difficulty solving mathematical problems in reading texts or questions, 2) students always misinterpret the problem, 3) if students do not understand the problem, they will guess the answer from the problem, 4) the students do not want to find out the solution of the problem given, 5) the students have difficulty in understanding the problem thus they cannot interpret it into symbol form.

Several studies were conducted to reveal the factors that affect students' performance in Mathematics. [7] discovered that, the students' ability, instructional, and social-psychological contextual elements are the factors that affect whether they like or dislike Mathematics. The findings also indicate that ineffective learning and assessment strategies, institutional resources, failure to comprehend instructions, and instructor didactic strategies are all factors which contribute to exam failure. Another study conducted by [8] which aims to investigate the six factors that influence International School secondary students' 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. According to the findings, self-efficacy is the characteristic that has the greatest influence on students' performance. The findings provide educators, schools, and other organizations with a better understanding of how to improve teaching and learning methods in order to increase students' self-efficacy in the classroom.

In order to forecast characteristics that affect students' achievement in Mathematics, [9] used five factors which are difficult problems, steps, understanding, word problem and effort. It was discovered that difficult problems, steps, and understanding have a significant impact on students' Mathematics achievement. Similarly, [10] discovered that interest, role of the teacher, peers and attitude are the factors that influence students' performance in Business Mathematics course at UiTM Kedah.

Besides, [11] investigated the factors that contribute to underachievement in Mathematics. This study was scaffolded by three suspected identified factors. The first is the teacher factor, which consists of subject matter mastery, instructional techniques and strategies, classroom management, communication skills, and personality. The second factor is the student, which includes study habits, time management, and attitude and interest in Mathematics. The third factor is the environment,

which includes parents' values, classroom settings, and peer group. The chi-square was used to identify the factors that affect the students' underachievement in Mathematics and the findings show that student factors such as study habits, time management, and attitude towards Mathematics influence the underachievement in Mathematics.

[12] studied the self-concept and academic performance in Mathematics of 183 Grade 10 students of a public national high school in Cebu, Philippines by using descriptive correlational research. The findings revealed that they have a moderate level of self-concept when it comes to learning Mathematics. There is no gender difference in the respondents' self-concept, but there is a significant relationship between self-concept and academic performance in Mathematics. As a result, a Mathematics performance enhancement plan is strongly advised for adoption and evaluation.

A study conducted by [13] focused on the differences in male and female students' behaviours and performance. The purpose of this study is to see if there are any differences in middle school students' attitudes and success in Mathematics between male and female students. The *t*-test and ANOVA were used on the data to determine the relationships between variables. The findings of this study show that students' attitudes towards Mathematics and achievement levels in Mathematics differ significantly by gender and grade level. Female students have more positive attitudes towards Mathematics than male students, and female students achieve higher grades than male students.

Therefore, this research will concentrate on the factors determination that may influence the performance of diploma students in Mathematics subject. The subject involved in this study is Pre - Calculus which was registered by most students of various UiTM programmes. This study included students from Diploma in Computer Sciences programme at UiTM Melaka Branch, Jasin Campus, which has had a failure rate of more than 25% since June 2019. In the UiTM system, a failure percentage greater than 25% is considered high.

2   MATERIAL AND METHODS

A total of 122 students in Diploma of Computer Sciences students from UiTM Melaka Branch, Jasin Campus, and students who took Pre-Calculus subject from October 2021 to February 2022 were considered. A questionnaire was modified from [14]. The questionnaire was disseminated through Google Forms and massages. The questionnaire consists of two sections which are Section A and Section B. In Section A, respondents needed to fill in their information such as gender, place of residence and grade for Pre -Calculus subject. In section B, the questions were focusing on the assessment marks; test 1, test 2, quiz 1, quiz 2, lab assessment, written assignment, time spent to study per week, information on Additional Mathematics during SPM, challenges in learning the subject and feedback on their lecturer. To find out the factors that are significantly associated with performance in mathematics, Chi-Square test of association has been performed. For the purposes of data analysis, the statistical software SPSS was used. Figure 1 shows the process of Chi-Square test of association.
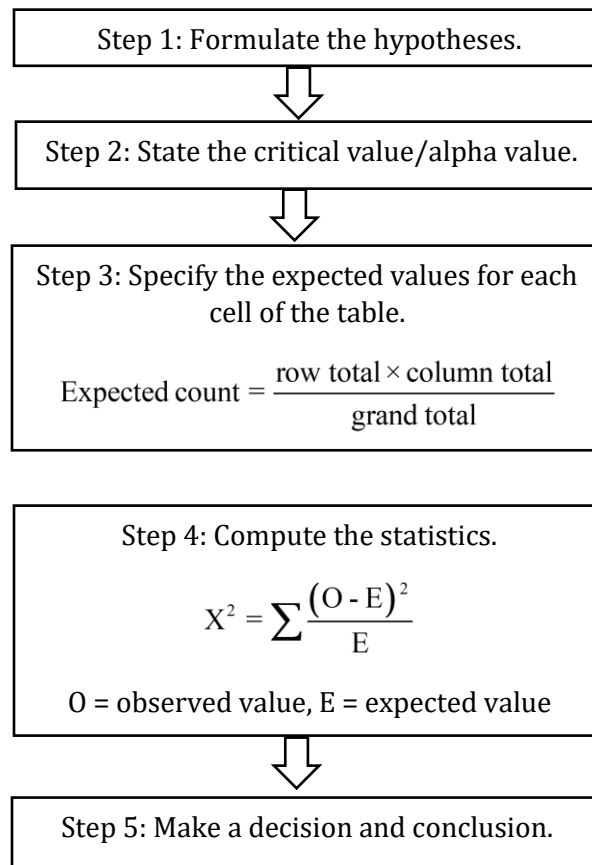
Step 1: Formulate the hypotheses.

Step 2: State the critical value/alpha value.

Step 3: Specify the expected values for each cell of the table.

$$\text{Expected count} = \frac{\text{row total} \times \text{column total}}{\text{grand total}}$$

Step 4: Compute the statistics.

$$X^2 = \sum \frac{(O - E)^2}{E}$$

O = observed value, E = expected value

Step 5: Make a decision and conclusion.

Figure 1: Process of Chi-Square test of association.

3 RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Respondents

This research involved a total of 122 students from CS110 in UiTM Melaka Branch, Jasin Campus as shown in Table 1. A total of 79 (64.8%) male students and 43 (35.2%) female students participated in this study. Most of the students stay outside the campus, and only 15.6% of the students stay in the hostel. This is due to the university regulation to conduct online classes or Online Distance Learning (ODL). During the COVID-19 pandemic, students did not have face-to-face classes. However, those with internet problems were allowed to stay at the hostel. 54.9% of the students did not take the Additional Mathematics subject in SPM, which shows that almost half of the students took Additional Mathematics in SPM. Most of the students passed Pre-calculus subject. Only 30 students did not pass the subject. Therefore, it can be said that the probability of the students who pass is 0.75 and for students who fail is 0.250.

Table 1: Sociodemographic Characteristics of Students

Variable		Frequency	Percentage (%)
Grade for MAT133	Fail	30	24.6
	Pass	92	75.4
	Total	122	100.0
Gender	Male	79	64.8
	Female	43	35.2
	Total	122	100.0
Place of residence	Off campus	103	84.4
	Hostel	19	15.6
	Total	122	100.0
Took Additional Mathematics in SPM	No	67	54.9
	Yes	55	45.1
	Total	122	100.0

Table 2 shows the descriptive statistics of the variables considered for 122 students of CS110. The result shows that the average time students spent studying Pre -Calculus is 6.32 hours. Overall, the assessments are giving a good average with the students scoring more than half marks for each assessment. For test 1 and test 2, the mean is 14.95 and 17.49 out of 20 marks, respectively. The means show that the average marks that students get are more than half of the total marks, and the students show an improvement in their test 2. Students score well in lab assignment as the average of their marks is 16.16 from 20 marks. For quiz 1 and quiz 2, they score an average of 8.17 and 8.22 out of 15 marks, respectively. This shows a good result as they get more than half of the total marks for the quizzes. The mean for the written assignment is 22.84 from the total mark, which is 30. Therefore, on average, students score in their assessments as the average of their assessments marks is more than half of the total marks.

Small standard deviation value means data are clustered around the mean, and large standard deviation indicates that the data are more spread out. For this model, the result shows that lab assignment has the best standard deviation as it has the lowest value, which is 2.844. It is indicated that the lab assignment variable is more consistent, whilst others tend to have less consistency because the values are spread out over a larger range.

Table 2: Descriptive Statistics of Quantitative Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Time spent studying MAT33 per week	122	0	21	6.320	4.299
Test 1	122	1	28	14.950	5.936
Test 2	122	3	30	17.490	6.047
Lab Assignment	122	6	21	16.160	2.844
Quiz 1	122	0	20	8.170	4.660
Quiz 2	122	0	15	8.220	3.685
Written Assignment	122	0	30	22.840	6.271

The students' feedback on their Pre -calculus lecturer is summarized in Table 3. Majority of students are pleased with the performance of their Pre -Calculus lecturer. They all agree that having the lecturer arrived early for class, followed by the lecturer creating a friendly atmosphere that encourages participation have contributed to positive performance in the subject. The students also agree that the lecturer used examples effectively in class and is always available to answer students' questions. Furthermore, the students agree that the lecturer motivates the class, is able to pique the students' interest in the course and recommends textbooks for readingVideo provides a powerful way to help you prove your point.

Table 3: Feedback on their Pre-calculus Lecturer

Variables	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Lecturer comes to class early	73(59.8%)	39(32%)	7(5.7%)	0(0%)	3(2.5%)
Lecturer makes good use of examples	65(53.3%)	43(35.2%)	10(8.2%)	0(0%)	4(3.28)
Lecturer motivates the class	60(49.2%)	45(36.9%)	14(11.5%)	0(0%)	3(2.5%)
Lecturer is able to awaken the interest of the students for the course	49(40.2%)	49(40.2%)	19(16.6%)	1(0.8%)	4(3.3%)
Lecturer creates a friendly atmosphere which encourages participation	71(58.2%)	35(28.69%)	13(10.7%)	0(0%)	3(2.5%)
Lecturer recommends textbooks for reading	43(35.2%)	45(36.9%)	28(23%)	5(4.1%)	1(0.8%)
Lecturer is always willing to deal with students' queries	62(50.1%)	45(36.9%)	11(9%)	1(0.8%)	3(2.5%)

3.2 Challenges in Learning Mathematics

Table 4 shows the challenges that students face in studying Mathematics. Most of the students, 78 of them, which is 63.93% believe that learning Mathematics is somewhat challenging, 37 (30.33%) of the students consider that Mathematics subject is difficult while the remaining 7 (5.73%) considered Mathematics is not a very challenging subject.

Table 4: Challenges in Learning Mathematics

Challenge	Number of Students	Percentage
Difficult	37	30.33%
Not very challenging	7	5.73%
Somewhat challenging	78	63.93%

Figure 1 shows the number of students for each difficulty in Mathematics subject. Majority of the students have difficulty in memorizing the facts, methods, and equations, followed by difficulty in analyzing theories, concepts, or ideas, and apply learned ideas in practical situations, while the least difficulties are making judgement about values of ideas followed by offering one's opinion and synthesizing new information or ideas. Figure 2 shows the student's responses regarding the

common challenges in learning Mathematics. Most of the students which is 22% said that they are unable to understand and memorize the formula, while the least challenges are careless which is 4%.
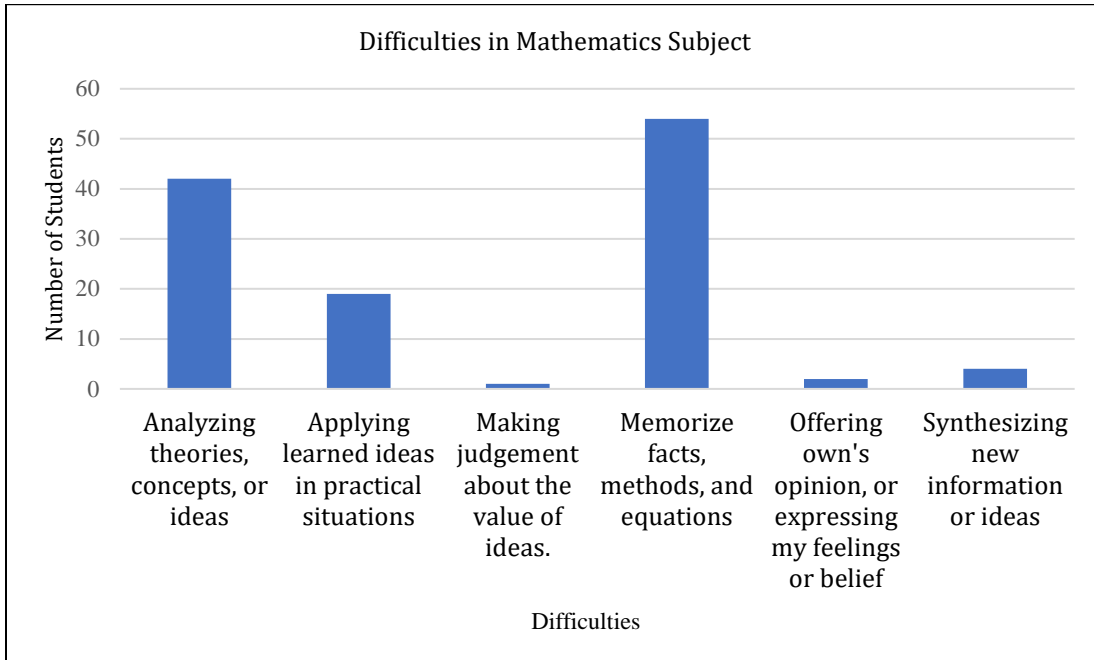

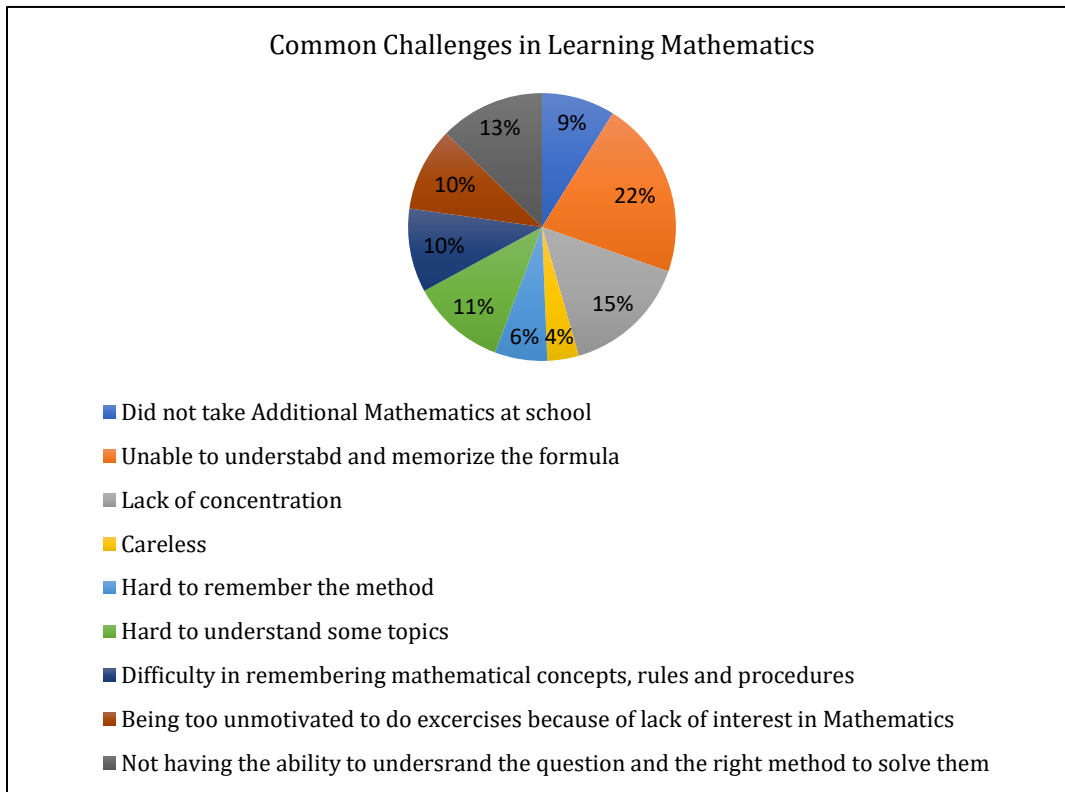Figure 1: Difficulties in Mathematics Subject

Figure 2. Common challenges in learning Mathematics

3.3 Factors that Affect Students' Performance in Mathematics

This section presents the data relating to the factors that affect the students' performance in Mathematics. The identified factors are gender, place of residence, and whether they took Additional Mathematics in SPM. The following null hypotheses were formulated:

i) H_{01} : There is no association between the students' grades in MAT133 and gender.

ii) H_{02} : There is no association between students' grades in MAT133 and whether they took Additional Mathematics in SPM.

iii) H_{03} : There is no association between students' grades in MAT133 and their place of residence.

The result was tested using Chi-Square (χ^2) test at 0.05 level of significance. In Table 5, the Chi-Square analysis (χ^2 = 11.110, *P*-value = 0.001) shows that there is an association between the students' grades in MAT133 and gender. Similarly with the Chi-Square analysis shows there is an association between the students' grades in MAT133 and whether they took Additional Mathematics in SPM (χ^2 = 11.110, *P*-value = 0.001). This implies that the relationship between gender and whether they took Additional Mathematics in SPM is significant with the students' performance in Mathematics. Place of residence has no association with the students' grades in MAT133 as can be seen from Chi-Square analysis with p-value = 0.332. Thus, it can be concluded that gender and whether they took Additional Mathematics in SPM factors directly affect the performance of students in Mathematics.

Table 5: Chi-Square Test on Relationship

Paired Variable	Computed χ^2	df	Critical value at 0.05	*P*-value	Interpretation
Performance in Mathematics and Gender	11.110	1	3.841	0.001	Significant
Performance in Mathematics and place of residence	0.940	1	3.841	0.332	Not Significant
Performance in Mathematics and whether they took Additional Mathematics in SPM	7.600	1	3.841	0.006	Significant

4   CONCLUSION

According to the current study, most students believe that learning Mathematics is somewhat difficult. For most students, the most difficult aspect of learning Mathematics is memorizing facts, methods, and equations. Because they did not take Additional Mathematics at school, the students are unable to comprehend the entirety or portions of the problem. Other challenges are analysing theories, concepts, or ideas, and applying learned ideas in practical situations, while the least difficulties are making judgements about the values of ideas, which is followed by offering one's own opinion and synthesising new information or ideas.

The Chi-Square test was used to achieve the goal of the study in identifying the relationship between the factors that affect the students' performance based on their grade in Mathematics subject, gender, place of residence, and whether they took Additional Mathematics in SPM. From the results, it is shown that the variables gender and whether they took Additional Mathematics in SPM are the factors which directly affect the performance of the students in Mathematics. The first factor fitted with [13] that stated that there is a significant difference between female and male students in terms of their success in Mathematics. Female students had more positive attitudes towards Mathematics than male students, and female students received higher grades. [15] revealed that good mathematics in primary schools affect the performance of students in Mathematics in higher level of education.

Lecturers should assign more homework and discuss the answers with their students in the next class to increase their students' sense of mastery and self-efficacy. Lecturers must also ensure that all students, complete the exercises given to them. Mathematics teaches students how to think critically and creatively. As a result, lecturers can try to develop critical thinking skills while teaching in order to train students to think creatively. [16] demonstrated that educator's collaboration can improve students' learning. In this study, the majority of students strongly agree with the lecturer's performance in teaching the Pre -Calculus Subject.

Based on these results, it is recommended for lecturers to provide more opportunities for students to solve non-routine problems in order to improve students' ability to solve Mathematics problems. Besides, students must practice and spend more time studying Mathematics in order to achieve a good result and avoid difficulties when taking Mathematics tests. In future, it is suggested that researchers use this as a reference to conduct additional research on students' difficulties in mathematical problem solving.

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