

## THE EFFECTIVENESS OF NEW TEACHING STYLE ON THE STUDENTS' PERFORMANCE IN VECTOR CALCULUS DURING MOVEMENT CONTROL ORDER

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### Abstract

Teaching style becomes more challenging especially during Movement Control Order (MCO) due to Covid-19 pandemic. Thus, online learning be one of the new teaching styles used during MCO at all educations level. Therefore, to study the effectiveness of this style, this paper is to investigate the effect of the new teaching style on engineering student's performance by determining the difference of overall scores between batches for each program in Vector Calculus (VC) course with ordinary and new teaching styles at Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM). Nonparametric test is used in this study is Mann Whitney to analyze the difference of the teaching style. The finding revealed that that students' achievements in VC course could significantly distinguished by two batches of students with different teaching and assessment modes. In contrast, JKPP program shows there is no significant difference in overall scores between batches with different teaching styles.

*Keywords:* Mann-Whitney Test; Students' Performance; Teaching Style; Vector Calculus

### Abstrak

Gaya pengajaran menjadi lebih mencabar terutamanya semasa Perintah Kawalan Pergerakan (MCO) disebabkan oleh pandemik Covid-19. Oleh itu, pembelajaran dalam talian menjadi salah satu gaya pengajaran baru yang digunakan semasa MCO di semua peringkat pendidikan. Oleh itu, untuk mengkaji keberkesanan gaya ini, kajian ini dijalankan untuk

meneroka kesan gaya pengajaran baru terhadap prestasi pelajar kejuruteraan dengan menentukan perbezaan skor keseluruhan antara kumpulan untuk setiap program dalam kursus Kalkulus Vektor (VC) menggunakan gaya biasa dan gaya pengajaran baru di Fakulti Kejuruteraan dan Alam Bina (FKAB), Universiti Kebangsaan Malaysia (UKM). Ujian nonparametrik digunakan iaitu Mann Whitney untuk menganalisis perbezaan gaya pengajaran. Hasil kajian menunjukkan bahawa pencapaian pelajar dalam kursus VC dapat dibezakan secara signifikan oleh dua kumpulan pelajar dengan mod pengajaran dan penilaian yang berbeza. Manakala, program JKPP menunjukkan tiada perbezaan yang signifikan dalam skor keseluruhan antara kumpulan dengan gaya pengajaran yang berbeza.

*Kata kunci:* Gaya Pengajaran; Kalkulus Vektor; Pencapaian Pelajar; Ujian Mann-Whitney

## 1.0 INTRODUCTION

Mathematics is a reflection of the active will, contemplative reason and the quest for aesthetic perfection, with logic and intuition, analysis and construction, generalization and individuality as the main ingredients (Courant & Robbins et al., 1996). According to Fennema and Sherman (1977), other subjects such as computing, chemistry and physics, use and study mathematics. Nearly every educational institution offers math subjects.

As per a previous study, the majority of university students struggled in mathematics classes (Jourdan et al., 2007). It is important to ensure the quality of the students' admitted to any higher education institution, as this as an impact on the institution's level of research and training (Oladokun et al., 2009). According to prior study, there are various factors that contribute to poor performance in engineering mathematics (Soo et al., 2015). These factors include a lack of basic comprehension of mathematics discipline, the fact that most students answer arithmetic problems by memorizing methods, a lack of confidence in dealing with non-routine questions, and reckless blunders during problem solving (Iannone et al., 2015).

Most of the universities in Malaysia including the Universiti Kebangsaan Malaysia (UKM) have moved forward to a new fully online teaching style and assessment mode during the Movement Control Order (MCO) due to Covid-19 pandemic compare to ordinary teaching style such as teaching physically instructing student. Engineering Mathematics is a major requirement for all tertiary engineering courses. Students in Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM) are required to take Vector Calculus (VC) course in the first semester for four different programmes which are Civil and Structural Engineering (JKA), Mechanical and Materials Engineering (JKMP), Chemical and Process Engineering (JKPP) and Electrical, Electronic and Systems Engineering (JKEES).

The usefulness of such a new teaching approach on student performance has been questioned. Because the impact of the new teaching method on student performance is crucial, two objectives are presented here. The first objective is to determine the difference of overall scores in Vector Calculus course with ordinary teaching style. Secondly is to determine difference in overall scores between batches with and without new teaching style for each of the programs.

## 2.0 MATERIALS AND METHODS

### 2.1 Mann-Whitney Test

Mann-Whitney U test is a non-parametric statistical tool for examining differences between two median of set data. In circumstances where the values inside the sample do not follow the normal or t-distribution, but also when the distribution of values uncertain, it can be used instead of a t-test for independent samples. To use the Mann-Whitney U, the values must be measured on a standard scale and of comparable size. Previous study, Roble et al. (2022) utilized the Mann Mann-Whitney U test to examine student level of mathematical cognition. Undergraduate students' library use, perceptions and grade point average (GPA) differ across science, technology, engineering and mathematics and non-step discipline according to Scoulas (2021). When both samples come from the same basic set or have the same median value, the Mann-Whitney U is also employed to test the null hypothesis (Milenovic, 2011). A number of assumptions must be met in order for the Mann-Whitney U test to be used. The most vital are: (a) coincidence of the sample and (b) independence of observations.

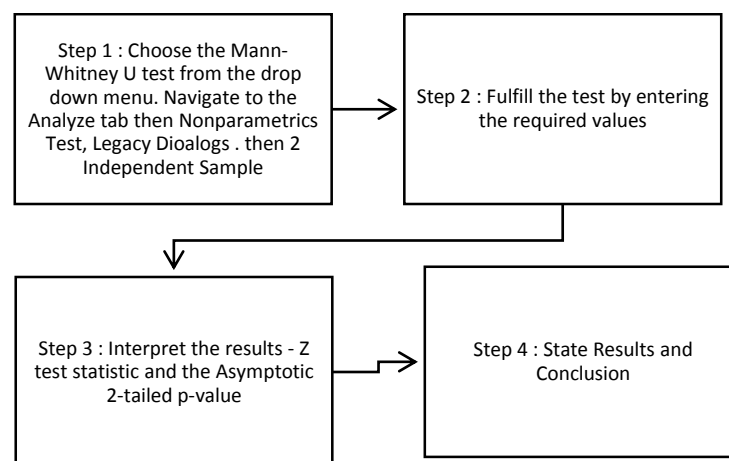


Figure 1: Flowchart Mann Whitney U test using SPSS Software

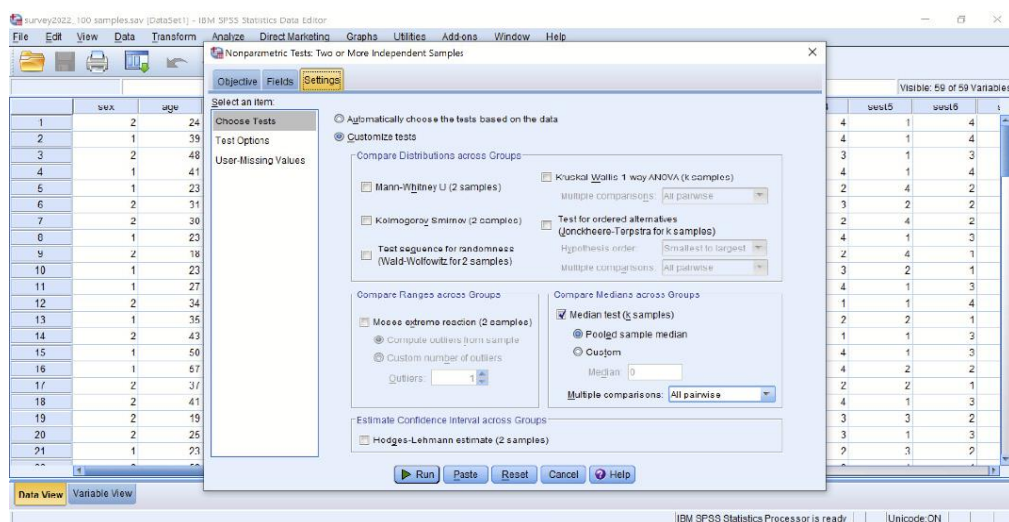


Figure 2: Example using test Mann Whitney U using SPSS Software

The Mann-Whitney U test is divided into two sections in the SPSS statistics application example at Figure 1 and Figure 2. The first section of the Mann-Whitney U test is the primary part, while the second part is the calculation of each group's media. The "Analyze" menu appears initially when the database to processed is active. The continuous dependent variable on teacher professional development is then transferred into the field Test Variable List, and then into the field "Grouping Variable", based on the profession of the instructor (class teacher/subject). It is important to choose the field "Define Groups" in order to encrypt the variable's data. Number 1 is put in the box adjacent to Group 1, and No. 2 is placed in the box next to Group 2. The command Continue is then selected, and the field Mann-Whitney U test is confirmed in the section Test Type. Finally, pick the option "Options" check the box for Descriptive, and enter the commands Continue and OK.

The process for computing the median of each group is covered in the second section. To begin, go to Analyze menu and pick Compare Means and Means. The dependent variable is then relocated to the Dependent List Field, and the criterion independent variable on the teacher's profession to the Independent List box. After that, the option Option is chosen. On this occasion, the Median is moved from the Statistics field to the Cell Statistics field, and the Mean and Standard Deviation are moved from the cell Statistics filed to the Statistics field. The commands Continue and OK are given at the end. The formula for determining  $U$  can be found in a textbook (Higgins, 2004),

$$U_1 = n_1 n_2 + \frac{1}{2} n_1 (n_1 + 1) - R_1 \text{ and } U_2 = n_1 n_2 + \frac{1}{2} n_2 (n_2 + 1) - R_2 \quad (1)$$

where  $n_1$  and  $n_2$  are the two sample sizes and  $R$  is the total of the ranks assigned to that particular sample if both samples are mixed up and ranked together (as if they do indeed come

from one population).  $U_1$  is taken as the lower value of  $U$  obtained for the two samples and is then compared to a table of values to see whether it is "significant" (Rouncefield, 1998). Mann-Whitney is a non-parametric version of the t-test (Ahammed & Smith, 2019). When the independent variable is limited to two categories, it is a suitable statistical test. Mann-Whitney is a well-known statistical approach for comparing the outcomes of two groups in statistical analysis. Mann-Whitney also known as Wilcoxon-Mann-Whitney, Mann-Whitney-Wilcoxon and Wilcoxon Rank tests, are a nonparametric test of the null hypothesis that the chance of  $X$  being higher than  $Y$  is equal to the likelihood of  $Y$  being bigger than  $X$ . This test as a comparison of the two populations' medians. Consider that the parameter test compares the median of independent group ( $H_0: \mu_1 = \mu_2$ ). The null and two sided research hypothesis for the nonparametric test, on the other hand, are as follow,  $H_0$ : There is no difference between the two population and  $H_1$ : There is a disparity between the two populations.

### 3.0 Results and Discussion

Figure 3 shows a Boxplot of students' performance in the Vector Calculus course by batches. The batches are listed as 2019 & 2020. The plot is a visual representation of data that is distributed around the median.

Values that are extremely high or low in a data set can appear to stand out from the rest of the data. Outliers are the data that fall outside of the norm. It usually indicates a data collection error or it could simply be valid data that stands out from the rest of the data set. The unusual data is valid for this study because it represents the student' final grades for each batch. Some students perform well in Vector Calculus, while others are below average. Figure 3 shows the outliers as asterisk (\*) in the box and whisker plot.

In comparison among the entire engineering students, batch of 2020 has highest median score than 2019. The highest score is 99% and 100% for batch of 2019 and 2020, respectively whilst the median score for batch of 2019 and 2020 are 71% and 80%, respectively. Based on Figure 2 we can also deduce that there are few outliers of lower marks and the distributions are skewed to the left for both batches. The results graphically show that the implementation of teaching via online during MCO due to Covid-19 pandemic for batch 2020 has increased the overall results of the students.

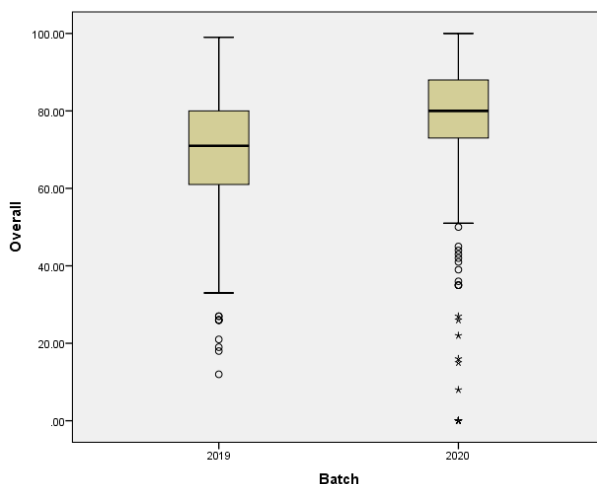


Figure 3: Final Scores by Batch

Mann-Whitney test is conducted to formally determine for any difference in Figure 3 score between batch of 2019 and 2020. Based on Table 1, the Mann-Whitney U is 116,378 with p-value is less than 0.05. The results indicated that it is highly likely that the scores are different between the two batches.

Table 1. Mann-Whitney Test of Score between Batches

Group (Batch)	Mann-Whitney U	P-Value
2019 and 2020	116,378	< 0.05

Figure 4 represents Boxplot from the overall performance of students in Vector Calculus course by batch across different programs. The plot is a visual representation of data that is distributed around the median. There are several outliers observed in almost all programs for both batches. Some students perform well in Vector Calculus, while others are below average. In comparison to students from similar programs in 2019, students from similar programmers in 2020 have the highest median scores. Highest median score is observed among JKMP followed by JKEES, JKMP and JKA students in 2020. A different pattern is shown in 2019 in which the highest median score is among JKEES followed by JKMP and JKA students. It is clearly shown that students from JKA has the lowest median score for both batches.

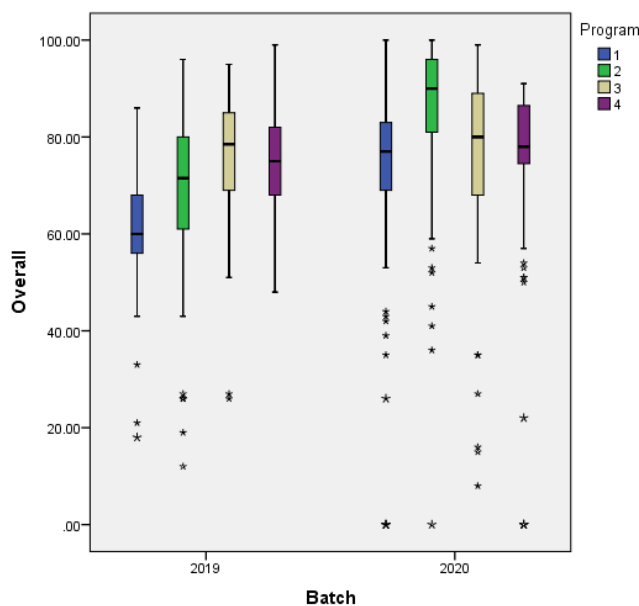


Figure 4: Final Scores by Batch across Program

Mann-Whitney test is carried out to formally determine for any difference in median score between batch for each of the programs. Based on Table 2, the Mann-Whitney U for JKA, JKMP, JKPP and JKEES are 6494.0, 11339, 3229.5 and 8509, respectively. The results indicated that it is highly likely that the median scores among the students between the two batches are different for JKA, JKMP and JKEES as the p-values are less than 0.05. In contrast, there is no sufficient evidence that the median score is similar for JKPP students between the two batches.

Table 2: Mann-Whitney Test of Score between Batches by Department

Group (Department)	Mann-Whitney U	P-Value
JKA	6494.0	< 0.001
JKMP	11339.0	< 0.001
JKPP	3229.5	0.337
JKEES	8509	0.027

**4.0 CONCLUSION**

The used of statistical median have successfully achieved the two objectives highlighted in the study. Firstly, the achievement of students in Vector Calculus course could be significantly ( $p < 0.05$ ) distinguished by two batches of students with different teaching and assessment modes. Secondly, there is only one program (JKPP) ( $p > 0.005$ ) that has no significant difference in overall scores between batches with different teaching styles while three program which are JKA, JKMP and JKEES have significantly different between batches with different

teaching styles ( $p < 0.05$ ).

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