

Impact of Advanced Organisers on the Performance of Students in Linear Differential Equations: A Case of Mukuba University, Kitwe District, Copperbelt Province, Zambia

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Abstract: - This study was done in order to show the impact of Advanced Organisers on the performance of students in Linear Differential Equations. The dismal performance of Second Year Students in Introduction to Analytical Geometry and Calculus (MAT 220) and Linear Differential Equations in particular at Mukuba University has been a thorny issue. To solve this problem a study was conducted by the Researcher. The study population included all Second Year students doing Introduction to Analytical Geometry and Calculus (MAT 220) pursuing a degree programme at Mukuba University. The study was based on one research question and two hypotheses. The research method used was an Experimental Design. The sample size was 60 students comprising 40 male and 20 female students. The Shapiro-wilk test was used for this purpose because of the small sample size. The two groups were made from a homogeneous class at random. Particular, 30 students were assigned to the Experimental Group and 30 students to Control group. These two groups were subjected to a pre-test. The experimental group was lectured using the Advanced Organisers while the Control group was lectured using Conventional methods. The analysis of data was done with the help of SPSS, considering the mean, standard deviation. Then an Independent sample t-test was conducted at $\alpha = 0.05$ to analyse the results of the pre-test and post-test scores. The study showed there was statistically significant difference in the post-test scores for Experimental group (Mean = 67.5, standard deviation = 19.5) and the control group (Mean = 49.8, standard deviation = 19.8), $P = .001$. Therefore, using Advanced Organisers when lecturing Linear Differential Equations was found to have an impact on students' performance.

Keywords: Advanced Organisers, Linear Differential Equations, Introduction to Analytical Geometry and Calculus, Conventional methods.

I. INTRODUCTION

Despite being a pre-requisite for (MAT 320) Advanced Calculus and (MAT 350) Mathematical and Applied Statistics which are Third Year courses to those majoring Mathematics, Introduction to Analytical Geometry and Calculus (MAT 220) is still posing a number of challenges to the Students. For instance, out of 67 candidates who sat for MAT 220 Examination in the 2013 academic year, only 32 candidates representing 48% passed the course while 45 (52%) failed the course. Out of 93 candidates who sat for

MAT 220 Examination in the 2014 academic year only 55 candidates, representing 59% passed the course while 38 (41%) failed the course which is not good for those majoring in Mathematics as the course is a. A further analysis on Linear Differential Equations showed that Students have not been performing well on this topic. For instance, out of 66 candidates who attempted questions on Linear Differential Equations in the 2013 Examination, only 14 candidates got the questions correct representing 21% while 45(79%) candidates failed questions on the topic. In 2014, 33% of the candidates who answered questions on Linear Differential Equations got the question correct while 67% failed. The 2017 academic year results showed that twenty four (24) candidates attempted questions on Linear Differential Equations in an Examination. Seven (9) candidates got the questions correct representing (38%) while 15 (62%) failed questions on Linear Differential Equations. It has been noted that a number of reasons could be attributed to the poor performance on the topic and one of the reasons could be the continuous use of Conventional lecturing methods. So the proposed study wished to determine whether, the Advanced Organisers could have a positive effect on students' performance on Linear Differential Equations. Advanced Organisers are a special package of meaningful learning which enhance academic performance among Students. The Advanced Organizers according to Ausubel (1978) is a tool or mental learning aid that help students to integrate the new information with their existing knowledge, leading to a "meaningful learning" as opposed to the rote learning (memorization).

1.1 Research objective

To determine the impact of Advanced Organisers on the performance of Students in Linear Differential Equations.

1.2 Research question

Does the Advanced Organisers have an impact on the performance of Students in Linear Differential Equations?

1.3 Scope of the Study

The research study was conducted at Mukuba University. This research targeted all Second Year Mathematics Students. Data was collected from these Students. The study was investigating the impact of the Advanced Organisers on the Performance of Students in Linear Differential Equations.

II. RESEARCH METHODOLOGY

2.1 Research Design

In line with Kothari (2004) a Research design is the conceptual structure within which the research is done. It is a blueprint for the collection, measurements and analysis of data. The design constitutes an outline of what the researcher did from writing the hypothesis and its operational implications to the final analysis of data. In other words, a research design can be defined as a plan, structure and strategy of a research to find out alternative tools to solve the problem and to minimize the variances. This study used Quantitative Research in order to assess the impact of the Advanced Organisers on the performance of Students in Linear Differential Equations. Quantitative Research in line with Kombo and Tromp (2004) is a sort of research which relies on the principle of verifiability. In this study quantitative data was obtained from Pre-test and Post-test. This study involved an Experimental research design. It is called an experimental because Students were chosen through simple random sampling methods. Furthermore, this research was called an experiment because its aim was to determine the impact of the independent variable on the dependent variable under study. In this regard, the Advanced Organisers were the independent variable, while Students' performance was considered as the dependent variable. Experimental design was used to determine the impact of the Advanced Organisers on Students' performance in Linear Differential Equations. Questions in the Pre-test and Post-test were based on Linear Differential Equations. The Experimental group was lectured using the Advanced Organisers while the Control group was lectured using Conventional Approaches.

2.2 Location of the Study

This study was carried out at Mukuba University in the Copperbelt Province of Zambia, Kitwe District in particular. The University is located 6 Km away from The Main Town Centre along Chingola road.

2.3 Target Population

Target population is the set of units to be studied according to John and Sons (2004). The target population of this study was 60 Students from Mukuba University.

2.4 Sample and Sampling Procedures

The study was done at Mukuba University, then two groups of 30 Students each were randomly chosen from a Class of Second Year Students majoring in Mathematics and a further random assignment was done to determine the Control group

and the Experimental group. The Experimental group was lectured using Advanced Organisers while the Control group was lectured using Conventional methods.

2.5 Data Collection Instrument/Techniques/Methods

The dependent variable in this study was performance in Linear Differential Equations.

To assess performance of Students, test questions were prepared and validated by the Researcher. Test questions were used for Pre-test and Post-test but were shuffled before being administered in the Post-test.

2.6 Pre-test measure

The Pre-test was given to the two groups. This test was administered before the intervention was done. This assisted in establishing the homogeneity between the Experimental and Control groups. The Experimental group received treatment in form of the Advanced Organisers while the Control group used the Conventional Approaches. The Students from Mukuba University were randomly assigned to Experimental group and Control group respectively. This was done by lottery method. The Researcher labeled 30 pieces of paper with letters **A** and the other 30 pieces with the letter **B** then asked each student to pick one paper at random. Those that picked a paper labeled **A** were taken to the Experimental group while those who picked a paper labeled **B** automatically became part of the Control group. The Experimental group was lectured using Advanced Organisers.

2.7 Post-test measurements

A Post-test was finally administered to the two groups after the intervention. The results were compared. The comparison was done between the Experimental group and the Control group Post-test scores. This was done in order to determine the group which achieved higher marks than the other. Performance of Students in these tests was the dependent variable while the independent variable was the Advanced Organisers.

2.8 Shapiro-wilk test

Before using a t-test, the data was first tested to determine if it was normally distributed. The normality check was important. If it wasn't checked, interpretations and inferences of results based on the data may be unreliable. There are many techniques that can be used to assess whether a set of data is normally distributed or not. Some known methods used to check for normality by Researchers are Jarque-Bera test, Shapiro-Wilk test, Kolmogorov-Smirnov and D'Agostino test. The Shapiro-Wilk test and Kolmogorov-Smirnov are used in almost similar instances. The Shapiro-Wilk test was chosen as the sample size was small. Kolmogorov-Smirnov test is used for bigger samples while the Shapiro-Wilk test is applied to smaller samples of say 40 or less. In line with Boyer (2013) the Shapiro-Wilk test for normality is valid only for small number of observations of say 5 and 38. The null hypothesis of this test is that scores should be normally distributed.

Moreover, if the P-value is less than the chosen level of significance, then the null hypothesis is not accepted. This would mean that the data isn't normally distributed. Then data analysis was done with the help of SPSS Version 16. Shapiro-Wilk normally test was done for the Control and Experimental group. The output column labeled 'Sig' which is the P-value was checked. If the column showed a number above 0.05, then the data was said to be normally distributed. In other words, the alpha level for two-tailed was set to 0.05. This significance level of 0.05 was used as opposed to 0.01 because, the more stringent a test is, and the most likely it is to find a statistically significant result as outlined by Kumar (2011). For the Shapiro-Wilk test, the closer the "sig" value is to 1, the more likely normal the sample is.

2.9 Independent sample t-tests

In line with IDRE (2014) the independent t-test is used to compare means of same variable between two groups. Independent sample t-test was done on the Pre-test scores for both the Control and Experimental group. This procedure was intended to compare the mean score of both the Control and Experimental groups. The SPSS Version 16 output columns also showed the columns labeled df for degree of freedom and t for t-statistic.

2.10 Conclusion

This Chapter has outlined the methodologies that were used in this research. It has also pointed out the suitable research design and data collection methods. The sole purpose of a research design used in this study was to maximize valid answers to the research question. The main concern of the Chapter was to map out how the research instrument was managed and used.

III. DATA PRESENTATION, ANALYSIS AND INTERPRETATIONS

3.1 Introduction

The Chapter discusses the findings of the research from the Pre-test and the Post-test which were administered to the students in order to find out the impact of the Advanced Organisers on the performance of Students' in Linear Differential Equations at Mukuba University in Kitwe District of the Copperbelt Province. This chapter presents data analysis and interpretation of empirical findings of the study. The result was presented using tables and each result was preceded by a brief analysis.

Table 3.2: Descriptive Statistics for the Pre-test

Test	Group name	N	Mean	Std. Deviation
Pre-test	Experimental	30	28.0	19.9
	Control	30	24.0	15.9

Table 3.2 shows the descriptive statistics and the difference in the Pre-test mean scores between the Experimental and Control group is 4.0. This very small difference in mean score indicated that the two groups started off at a comparatively same level. The mean for the Experimental group Pre-test scores was 28.0, Standard deviation was 19.9 and the mean for the Control group was 24.0, standard deviation was 15.9. This difference is statistically insignificant showing that the results could not happen by chance.

Table 3.3: Descriptive Statistics for the Post-test.

Test	Group name	N	Mean	Std. Deviation
Pre-test	Experimental	30	67.5	19.5
	Control	30	49.8	19.8

Table 3.3 shows the descriptive statistics and the difference in the Pre-test mean scores between the Experimental and Control group is 17.7. This very big difference in mean score indicated that the two groups after treatment differed in abilities. The mean for the Experimental group Post-test scores was 67.5, Standard deviation was 19.5 and the mean for the Control group was 49.8, standard deviation was 19.8. This mean difference is statistically significant.

3.4 The Shapiro-wilk normality test

The assumption which was observed before the t-test was that the data collected was normally distributed. The first step was, therefore, to use the Shapiro-wilk procedure to test for normality. The procedure was carried out to check out that the assumption was not violated. A t-test could only be used effectively if the data under investigation is normally distributed. Table 3.5 shows the results generated using Statistical Package for the Social Sciences (SPSS) software.

Table 3.5: Shapiro-wilk normality test for Experimental and Control groups

	Shapiro-Wilk		
	Statistic	Df	Sig.
Pretest Score	.899	60	.008
Posttest score	.944	60	.064

In this cases the normality test indicates a Shapiro-wilk value of more than 0.05 for the post-test. This indicated that the data is normally distributed and implied that the t-test could be used.

Table 3.6: Independent sample t-test for the Experimental and Control groups for Post-test

Type of test	t-test for Equality of Means						
	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Pre-test equal Variances Assumed	-3.504	58	.001	-17.67	5.04	-27.76	-7.58

Table 3.6 presents the independent sample t-test for the Experimental and Control group of Post-test. An independent sample t-test was also used to analyse whether there was a significant difference between the mean scores of the Experimental group and the Control group for the Post-test after administration of the treatment to the Experimental group. There was a statistically significant mean difference in the Post-test scores ($P\text{-value} = 0.001 < \alpha = 0.05, t = -3.504$). This result illustrated that the students in the Experimental group outperformed the Control group. Hence, the Advanced Organisers had an impact on the performance of Students in Linear Differential Equations.

IV. DISCUSSION AND CONCLUSIONS

This study investigated the effect of the Advanced Organisers on the Students' performance in Linear Differential Equations by Students of Mukuba University of Kitwe District of the Copperbelt Province. Findings of the study have been presented in the preceding Chapter. The findings suggest that there is need to address the challenges that have been identified if the quality of learning and lecturing in Mathematics is to improve. The results indicated that using the Advanced Organisers in lecturing Linear Differential Equations in Mathematics does have an impact on the performance of Students. This Chapter hopes to discuss the findings of the study. The discussion of the findings will focus on how one research question which was addressed. The analysis and general discussion of this Chapter is arranged according to the unit of analysis sometimes referred to as research participants and was framed by the following research question;

- Does the Advanced Organisers have an impact on the performance of Students in Linear Differential Equations

4.1 Impact of the Advanced Organisers on the performance of Students in Linear Differential Equations

The study showed that after running the independent sample t-test for the Experimental and Control group for the Post-test at Mukuba University there was a statistically significant mean difference between the mean scores of the Experimental group and the Control group after administration of the treatment ($P\text{-value} = 0.001 < \alpha = 0.05, t = -3.504$). Furthermore, the results showed that the Experimental group had a mean score of 67.5, standard deviation 19.5 while the Control groups mean score was 49.8, standard deviation 19.8 which gave a mean score difference of 17.7. The

comparatively big difference in mean scores indicated that the Experimental group achieved higher than the Control group hence the Advanced Organisers had an impact on the performance of Students in Linear Differential Equations.

4.2 The measures to be undertaken in order to improve lecturing of Linear Differential Equations

In this section, the focus is on measures to be undertaken in order to improve Students' performance and lecturing by use of the Advanced Organisers by Lecturers as an effective Approach. From the results of the t-test in **Table 3.6** showed that there was a significance differences in the Post-test. This was an indication that Advanced Organisers should be implemented in Universities and Secondary Schools and be used in other Courses or subjects. Other measures to be undertaken by the School Administrators to improve the performance of Students in their respective Universities should include implementation of the following; Seminars, Conferences, Symposiums, Topical tests and Club activities such as Mathematics Club.

The Control group mean score for the Post-test was ($M = 49.8, SD = 19.8$) and the mean score for the Experimental group was ($M = 67.5, SD = 19.5$). The mean difference was statistically significant, $P < 0.05$.

- The Experimental groups mean score for Pre-test was ($M = 28.0, SD = 19.9$) and the mean score for Control group was ($M = 24.0, SD = 15.9$).
- The mean for the Experimental group Post-test score ($M = 67.5, SD = 19.5$) and the mean for the Control group Post-test score was ($M = 49.8, SD = 19.8$). The difference was statistically significant, $P < 0.05$. These result suggested that lecturing Linear Differential Equations using the Advanced Organisers in Mathematics did have an impact on the achievement of high scores by Students.

4.3 Key Findings

- The mean score for the Control group Post-test was significantly higher than the mean score for the Pre-test. The Control group used Conventional Approach. These results, therefore, implied that the use of Conventional Approach also improved pupils' achievement.
- The mean score for Experimental group Post-test was significantly higher than the mean score for the Pre-test. The Experimental group used Advanced

Organisers. These results, therefore, implied that the use of Advanced Organisers improved pupils' achievement.

- The mean for the Experimental and Control group Pre-test score were statistically insignificant. This implied that the Control and Experimental group started at the same level. No group was academically superior to the other.
- The mean for the Experimental and Control group Post-test scores were statistically significant. The fact that the Control and Experimental group started at the same level, then the difference that was observed between the Post-test score was due to the treatment. The Experimental group outperformed the Control group. The use of Advanced Organisers,

therefore, more successful than Conventional Approach.

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