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FLEXAMPLE : Integrating on Plane and Solid Geometry among First Year BSED Math to Enhance Mathematics Performance

[a]Vaneza Rose V. Noynay, [b]Lyn T. Monleon, [c]Mairen A. Doquidoc, [d]Rejeane B. Pellejera, [e]Josie O. Prudenciado, [f]Julie Angel C. Cordova, [g]Arnel B. Lipon, [h]Angelo C. Pring, [i]Mike D. Bucado, [j]Michelle O. Serafin, [k]Dr. Marnel M. Bullo, [l]Dr. Richard C. Ching, [m]Lester V. Gonzales, [n]Emilita May B. Abarca

[a-n] Cataingan Municipal College, Cataingan, Masbate Philippines

A B S T R A C T :

This action research was conducted to ascertain the effectiveness of FLEXAMPLE (Flexible Teacher-Provided Examples) activity in the learning activity sheets in enhancing the learned the depth concepts on Plane and Solid Geometry among the first-year students, BSED Mathematics of Cataingan Municipal College. Through the used of quasi-experimental design and quantitative research method, the pretest, posttest and leaning activity sheets which are easy, average and difficult in level, which were successfully executed. The learning activity sheets are made to assessed the extent of certain plane and solid geometry content: Plane and Solid Figures, Perimeter of Regular Polygons, Trigonometric Ratios, and Area of Regular Polygons. This custom-made learning activity sheets are available with three different difficulty levels and was designed, developed and implemented across the FLEXAMPLE intervention. The pretest and posttest scores of both controlled and experimental group were found to be not normal by Shapiro-Wilk's normality test and therefore Wilcoxon Signed Rank Test was done a non-parametric test analysis which does not assume that the values come from a normally distributed population for grip strength. In contrast to the expectations, the outcome of FLEXAMPLE intervention did not significantly improve student learning outcomes. The findings suggest that the intervention may be more effective with a different group of learners, and future research should focus on refining the intervention or exploring alternative approaches and investigate its effectiveness with alternative populations.

Keywords: FLEXAMPLE intervention in a way of learning activity sheets, plane and solid figures, perimeter of regular polygons, trigonometric ratios and area of regular polygons, quasi-experimental design, quantitative data analysis approach, mathematics performance

1. Introduction

Mathematics education plays a vital role in developing critical thinking, problem-solving and analytical skills among students. However, many students struggle with mathematics particularly in complex and abstract concepts such as Complex Plane and Solid Geometry. This research addressed the poor performance, low-esteem and decreased motivation of the learners in learning mathematics. Heibert et al., (1992) states that some students struggled in understanding abstract concepts of complex plane and solid geometry leading to frustration and decreased motivation because of the difficulty of the subject.

To address this challenge, the researchers introduced the FLEXAMPLE (Flexible Teacher-Provided Examples) intervention in a way of learning activity sheets. Kortenkamp (2011) and Leung (2017) posited that different examples can lead to improved mathematics performance among students and can increased students' motivation and engagement in mathematics, leading to a more positive attitude towards the subject. Arcavi and de Villiers (2003) stated that students can developed deeper understanding of mathematical relationships and connection by integrating complexity of the subject. And the National Council of Teachers of Mathematics (2014) stated that different examples can help students developed critical thinking and problem- solving skills, which are essential for success in mathematics and other STEM fields.

This study examined the effectiveness of the implementation of FLEXAMPLE (Flexible Teacher-Provided Examples) intervention in a way of learning activity sheets. This served as a guide of diverse learners in acquiring deep concepts of Plane and Solid Geometry by following the strategies given in the learning activity sheets making the concepts more engaging and easier.

1.1 Statement of the Problem

This action research aimed to identify effective teaching strategies for CMC first-year BSED Mathematics students by providing learning activity sheets with flexible examples that enabled the students to developed a deep understanding of mathematical concepts, thereby laying strong foundation for academic success in their remaining three years in college. The study investigated the following questions: What is the level of mathematical performance

in Complex Plane and Solid Geometry based on the pre-test and post test results of first year BSED Mathematics students after implementing FLEXAMPLE intervention? And does the FLEXAMPLE intervention enhance the mathematical performance of first-year BSED Mathematics students?

2. Methods

2.1 Research Design

As for the research strategy, the data was collected through structured learning activity sheets alleged to be both formative assessment and instructional materials. The students' understanding of the topic Plane and Solid Geometry: Plane and Solid Figures, Perimeter of Regular Polygons, Trigonometric Ratios and Area of Regular Polygons was evaluated with learning activity sheets. This learning activity sheets, designed to meet the students' learning needs with varying degrees of difficulty, were developed and integrated into FLEXAMPLE intervention which included flexible examples of varied activities with application of concepts, visual representations, and problem-solving exercises. The goal was to enhanced students' understanding using active learning and scaffolded instruction. Combating misconceptions, this study employed a quasi-experimental design featuring the application of blended theoretical and visual instruction modules on complex analysis and underscore spatial reasoning.

2.2 Data Sources

The primary data sources for this study involved all the learners of first year CMC BSED Mathematics (Block B and Block K) that timely taking the Plane and Solid Geometry subject. The study consisted of two groups: Block B as the control group who received traditional instruction without the FLEXAMPLE intervention and Block K as the experimental group who received the FLEXAMPLE intervention, which utilized learning activity sheets. The collection of data focused on students who had completed the entire set of learning activity sheets with flexible examples in the experimental group since the study was utilized by a quasi-experimental design (Campbell and Stanley, 1963).

A quantitative analysis of the pretest and posttest scores was conducted to evaluate the effectiveness of FLEXAMPLE intervention by the used of learning activity sheets. Using the Shapiro-Wilk test the normality of the data in both control and experimental group was not normally distributed. It is very important to check the normality in educational research and the consequences of violating normality assumptions because if the data isn't normally distributed, it can lead to inaccurate results, misleading interpretations and inappropriate analysis (Keskin. 2011).

2.3 Research Procedure

This study involved two blocks of first-year CMC BSED Mathematics students: Block B served as the control group (n = 48), while Block K was the experimental group (n = 49). Prior to implementation, the researchers secured formal approval from the college head and the college dean to ensure alignment with institutional policies and ethical standards (Fraenkel, Wallen, & Hyun, 2012). Additionally, informed consent was obtained from all participants. They were briefed on the study's purpose, procedures, and their rights, including the right to withdraw at any time without academic consequences.

The FLEXAMPLE intervention was designed to scaffold the complexity of Plane and Solid Geometry concepts into more manageable and accessible components, promoting conceptual understanding. The instructional materials—including pretest, posttest, and learning activity sheets—focused on topics such as plane and solid figures, perimeter, and area of regular polygons. These materials were validated by mathematics education experts to ensure content relevance and accuracy (Cheung & Slavin, 2013).

To ensure methodological rigor, the researchers systematically documented all procedures and employed appropriate statistical techniques to address potential biases (Trochim, 2006). Data from the pretests, posttests, and activity sheets were anonymized before analysis to protect participant privacy and ensure objectivity (Shadish, Cook, & Campbell, 2002).

The normality of the data was assessed using the Shapiro-Wilk test via the Jamovi statistical software. The results indicated that data from both the control and experimental groups were not normally distributed. Consequently, the researchers utilized non-parametric statistical tests, which do not assume normality, to analyze the effectiveness of the FLEXAMPLE intervention.

3. Results and Discussion

3.1 Normality Test of Data in Controlled and Experimental group

The study looked at how effective the implementation of FLEXAMPLE in enhancing the performance of first year BSED Mathematics students of Cataingan Municipal College in complex plane and solid geometry. The pretest measured the prior and initial knowledge of the students and the posttest that was given after the intervention, assessed improvement.

The table 1 below shows the findings from the normality tests of control and experimental group during the pretest and posttest stages. The results of the Shapiro- Wilk normality test in both control and experimental group showed that both pretest and posttest was not normally distributed. In particular, the

pretest of the controlled group (Block B) recorded a w-statistic value of 0.892 and a p-value of <0.001. The posttest displayed w-statistic value of 0.913 and a p-value of 0.002. The pretest of the experimental group (Block K) recorded a w-statistic value of 0.937 and a p-value of 0.011. The posttest displayed a w-statistic value of 0.928 and a p-value of 0.05. Therefore, the result was not normally distributed because the w-statistic is relatively low and does not reach to 1 and the p-value was less than the significance level 0.05. Even though the p-value of the posttest results of the experimental group had reached the 0.05 but still not normally distributed because of the w-statistic that does not reach to 1.

Due to the violation of the normality assumption, the Wilcoxon signed-rank test was utilized for additional statistical evaluation. Conover (1999), provides guidance on using the Wilcoxon Signed Rank Test for paired data that violates normality assumptions. Wilcoxon (1945), the original paper introducing the Wilcoxon Signed Rank Test, a non- parametric alternative to the paired t-test.

Table 1
Normality Test of Data

Group	Variable	W-stat	P-value	Interpretation
Control group	**Pretest**	**0.892**	**<0.001**	**Not normally distributed**
	Posttest	**0.913**	**0.002**	**Not normally distributed**
Experimental group	**Pretest**	**0.937**	**0.011**	**Not normally distributed**
	Posttest	**0.928**	**0.005**	**Not normally distributed**

3.2 Statistical Interpretation of Pretest and Posttest of the Control Group (Block B)

The table 2 below displayed the results of the Wilcoxon signed-rank test performed to assess the results of the pretest and posttest stages. A non-parametric was required since the Shapiro-Wilk test indicated that the data did not follow a normal distribution. With regards to this issue, the Wilcoxon signed rank test that evaluates the median difference between paired observations, providing insight into the effectiveness of the intervention was utilized.

The statistical outcome produced W=118 and a p-value of 0.029, surpassing the 0.05 significance level. This suggested that there was no significant difference between the pretest and posttest results. The null hypothesis was sustained, while the alternative hypothesis was dismissed. Clearly stated that the Block B was indeed defended as the controlled group knowing that they are not exposed in the intervention. Therefore, the result was reliable and accurate. The control group was remained stable or unchanged, which is expected of they weren't exposed to the intervention (Shadish et al., 2002).

Table 2
Statistical Interpretation of Pretest and Posttest of the Control Group (Block B) Using Wilcoxon Signed-Rank Test

Variable	N	S-W	p-value	Interpretation
Pretest-Posttest	48	118	0.029	Statistically not significant

3.3 Statistical Interpretation of Pretest and Posttest of the Experimental Group (Block K)

The following table 3 below showed the outcome of Wilcoxon Signed Rank test that compared the pretest and posttest phases. Following the use of the FLEXAMPLE intervention, a data collected do not also conform to the normal distribution. Due to this problem, the use of non-parametric test is necessary.

The statistical result yielded W=39.0 and a p-value of <0.001, which indicates that there was a statistically significant difference between the results of the pretest and posttest. This result confirmed the success of the implementation of the FLEXAMPLE intervention. A null hypothesis was rejected and an alternative hypothesis was supported. The significant findings in the experimental group are evidence of the efficacy of the FLEXAMPLE intervention (Durlak et al., 2011).

Table 3
Statistical Interpretation of Pretest and Posttest of the Experimental Group (Block B) Using Wilcoxon Signed-Rank Test

Variable	N	S-W	p-value	Interpretation
Pretest-Posttest	**48**	**39.0**	**<0.001**	**Statistically significant**

4. Conclusion

This study in titled "FLEXAMPLE: Integrating in Plane and Solid Geometry among First Year BSED Math to Enhance Mathematics Performance" investigated the effectiveness of the FLEXAMPLE intervention on learning outcomes among BSED Mathematics students. The findings revealed that the intervention did not significantly improve learner outcomes, contrary to expectations. The non-parametric tests, specifically Wilcoxon Signed Rank Test was utilized to ensure the reliability of results and accurate assessed intervention effects (Wilcoxon, 1945).

Alternatively, the FLEXAMPLE intervention may not be effective for this particular group of learners or may require modifications to enhance its impact. Future research should explore more alternative approaches, investigate the intervention's effectiveness with different populations, or examine potential adjustments to improve its effectiveness.

Overall, this study concludes that the findings contributed to the understanding of the FLEXAMPLE intervention's limitations and potential areas for improvement, informing future research and educational practice. Making abstract concepts more manageable and easier to understand, really needs a brief consideration and professional practice to facilitate deeper understanding and effective practice adapting diverse learners' needs.

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