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METHODOLOGY APPRAISAL OF EXPERIMENTAL RESEARCH STUDIES IN MATHEMATICS TEACHING

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Abstract

This study made use of Gene Glass Effect Size formula to estimate the mean effect sizes of the eleven (11) reviewed experimental research studies on the effect of experimental and conventional teaching and learning strategies to the academic performance of students in mathematics. A validated Inclusion Criteria was utilized in the selection of studies and a modified Methodology Appraisal Checklist was employed in the analysis of elements of the research problem and research methodology. The mean effect sizes and variances of the reviewed studies vary across the elements of the research problem and methodology, an indication that teaching and learning strategies are dependent on the quality of methodology used by the researcher. This study stressed that there is no enough evidence to prove that experimental teaching and learning strategies are more effective than conventional pedagogies in improving learnings in math, as the analysis of variance (ANOVA) revealed a p-value of 0.982 (critical value=0.05).

Research Highlights

The findings of this study highlights the positive effects of experimental teaching strategies when study focuses on the following variables: elementary and secondary learners; private schools; three to six months duration of study; activity-oriented teaching strategies; two-experimental—one-control group and single-group design; instructor-researcher role; directional hypothesis setting; pre-test—post-test desing; intact group sampling; using Analysis of Variance method; using researcher's made instrument; using face and content validation; and using Kuder-Richardson 20, Cronbach α , Test-Retest methods of reliability testing. However, conventional teaching strategies have positive effects when study focuses on the following variables: tertiary learners; public schools; enrich-lecture strategies; one-experimental—one-control group design; using simple random sampling and matched-group sampling; using Analysis of Covariance method; and using split-half method in reliability testing. The preceding highlights call for future studies that will carefully address the complex domain of mathematics teaching in different contexts, the evaluation strategies, the effectiveness of the math curriculum, and learners' achievements (Ginsburg & Golbeck, 2004).

Graphical Abstract

Fig. 1. shows the areas of research problem and research methodology where both experimental and conventional teaching strategies obtained positive mean effect sizes.

Research Objectives

This study aimed at consolidating and amalgamating findings from various experimental research studies on the effect of teaching and learning strategies on the performance of students in mathematics through the Gene Glass Effect Size Formula and at appraising the methodological quality of these research studies. This objective is possible by averaging the effect sizes across studies under investigation through combining the effect sizes of individual studies (Hedges & Kuyper, 2015). It analyzed the magnitude of a treatment effect from some individual or group experimental research studies based on the elements of research problem and research methodology. The findings of this research provided those who believe that there are still areas in mathematics education that need further improvements like the strategies

commonly used by many math teachers and the methods and principles used by many educational researchers. Further, the findings of this meta-analytical study have provided new hypotheses that future researchers can investigate.

Methodology

A systematic review of studies connotes a well-structured research questions from which a defined search strategy and protocol are made to aid the researcher to decide whether to include or exclude a particular study based on the selection criteria. If this review contains a statistical synthesis of individual studies to arrive at a single statistical information, then this method becomes meta-analysis (Gogtay & Thatte, 2017). Hence, a manual search of the unpublished literatures was carried out to identified higher education institutions in the Caraga Region, namely Surigao Del Sur State University, Caraga State University, Philippine Normal University-Mindanao, and Saint Theresa College of Tandag. These studies were screened through researcher's made inclusion criteria. The assessment of the methodological character of the reviewed studies was done using a modified appraisal checklist. This study assumed that the effect size is the numerical indicator of the effectiveness of a teaching strategy used in teaching math. The findings from experimental studies were synthesized using the Gene Glass Effect Size Statistic. This statistical method describes the strength of differences between the variables of all studies covered by meta-analysis (Shelby & Vaske, 2008). The computation of the effect size Δ was done by subtracting the post-test mean score of the control group ($\bar{x}_c$) from the post-test mean score of the experimental group ($\bar{x}_e$) and dividing the difference by the post-test standard deviation of the control group (S_c). The experimental teaching strategies are effective than the traditional teaching strategies if the effect size Δ is positive. Otherwise, it is negative if traditional teaching strategies are far more effective than experimental teaching strategies. The inferences that follow are solely based on the signs of the mean effect sizes.

Results

This study shows that the reviewed studies were homogeneous based on the inclusion criteria (i.e. mathematics teaching, experimental research, completed from year 2000 to year 2018, reported appropriate statistics). Based on the elements of the research problem, the reviewed studies that were conducted among private elementary and secondary schools yielded a positive

mean effect size. Also, studies that employed activity-oriented teaching strategies and were conducted within three (3) to six (6) months period have yielded a positive mean effect size. Further, based on the elements of research methodology, the use of directional hypothesis setting, pre-test—post-test design, intact groupings of subjects, Analysis of Variance to test significant difference, researcher's made questionnaire, face and content validation of questionnaires, tests of reliability (i.e. Kuder-Richardson 20, Cronbach α , test-retest), and high-levels of reliability coefficients have yielded positive mean effect sizes.

Findings

The ANOVA yield a computed p -value 0.982 which is higher than the critical value 0.05. This finding stressed that there is no significant difference in the mathematics achievement of students between the experimental and control groups with respect to the findings of the studies included in this meta-analysis. With respect to the reviewed research papers, the scores of students taught using experimental teaching strategies did not statistically differ from the scores of those taught using the conventional.

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Author's Biography

Born on September 8, 1994 in Tandag City, Province of Surigao del Sur. Completed elementary education in 2006 at Rosario Elementary School; completed secondary education in 2010 at Jacinto P. Elpa National High School; graduated Bachelor of Secondary Education major in Mathematics in 2014 at Surigao Del Sur State University—Tandag City Campus; and graduated Master of Science in Teaching Mathematics in 2019 at the same university. Presently a faculty member of the Mathematics Department of Polytechnic University of the Philippines—Parañaque City Campus, handling undergraduate courses in Calculus, Differential Equations, Advanced Engineering Mathematics, Discrete Mathematics, Engineering Data Analysis, Quantitative Methods, Mathematics of Investment, Business Finance, and Accounting.