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Investigating the Impact of the 5Cs Framework on Geometry Achievement Among Senior Secondary School Students in Makurdi Metropolis, Benue State, Nigeria

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ABSTRACT

This study investigated the impact of the 5Cs framework (presumably referring to a set of pedagogical principles, though the exact nature needs clarification) on senior secondary school students' achievement in geometry within Makurdi Metropolis, Benue State, Nigeria. The research addressed concerns about student performance in mathematics, particularly geometry, and the potential of contemporary teaching approaches to improve learning outcomes. The study employed a quasi-experimental design. Data was collected and analyzed to determine the effect of the 5Cs framework on students' geometry achievement.

Keywords: 5Cs Framework, Geometry Achievement, Senior Secondary School, Makurdi, Benue State, Nigeria, Critical Thinking, Creativity, Collaboration, Communication, Citizenship, 21st Century Skills, Mathematics Education.

INTRODUCTION

Mathematics is a fundamental subject with applications across various disciplines and in everyday life [3]. Geometry, a branch of mathematics, is crucial for developing spatial reasoning and problem-solving skills, and its importance for technological development in Nigeria has been emphasized [3, 27]. However, students often struggle with geometry, leading to poor performance [22, 28]. Several factors contribute to this challenge, including traditional teaching methods, lack of resources, and students' attitudes towards the subject [14, 28].

Research has explored various strategies to improve mathematics education, including the use of games and simulations [1, 29], Geometer's Sketchpad [2, 13], computer animation and geometrical instructional models [10], ethno-mathematics approaches [19], activity-based learning [8], e-learning [23], and guided scoring instructional strategies [12]. The 5Cs framework, as described by Aungst [6], represents a set of modern mathematics classroom principles, though the specific principles (Connection, Communication, Critical Thinking, Challenge, and Creativity) need to be clearly defined within the context of this study. This study aims to examine the effectiveness of the 5Cs framework in enhancing senior secondary school students' achievement in geometry in Makurdi Metropolis, Benue State, Nigeria.

METHODS

Design

The study employed a quasi-experimental design. This design was chosen because it allows for the investigation of cause-and-effect relationships in educational settings where random assignment of participants to groups is often not feasible. Specifically, a pre-test, post-test control group design was used.

Participants

The participants were senior secondary school (likely SS2) students in Makurdi Metropolis, Benue State, Nigeria. A sample of [Number] schools was selected using [Sampling Technique, e.g., stratified random sampling] to ensure representation across different

school types (e.g., public, private). Within each selected school, [Number] intact classes were chosen, and these classes were then assigned to either the experimental or the control group. The total sample size for the study was [Number]. The demographic characteristics of the participants, including age and gender distribution, were recorded.

Instrument

A geometry achievement test (GAT) was developed by the researchers to measure students' understanding of geometry concepts. The GAT consisted of [Number] questions, covering topics such as [List key geometry topics, e.g., lines and angles, triangles, quadrilaterals, circles, and basic geometric proofs]. The validity of the GAT was established through [Mention validity procedure, e.g., expert review by mathematics educators], and the reliability was determined using [Mention reliability procedure, e.g., Cronbach's alpha, Kuder-Richardson formula 20], with a reliability coefficient of [State reliability coefficient, e.g., 0.85].

Procedure

The study was conducted over a period of [Duration, e.g., six weeks]. Prior to the intervention, the GAT was administered to both the experimental and control groups as a pre-test. The experimental group received instruction in geometry using the 5Cs framework. The 5Cs framework, as implemented in this study, involved the following principles:

- Connection: Lessons were designed to link geometric concepts to real-world applications and to other areas of mathematics.
- Communication: Students were encouraged to discuss their understanding of geometry, both verbally and in writing, and to explain their problem-solving processes.
- Critical Thinking: Instruction emphasized the development of students' abilities to analyze geometric problems, make conjectures, and justify their reasoning.
- Challenge: Students were given challenging geometry problems that required them to apply their knowledge in new and complex situations.
- Creativity: Students were encouraged to explore different approaches to solving geometry problems and to develop their own geometric constructions and designs.

The control group received instruction using the conventional teaching method, which typically involved [Describe the conventional method, e.g., teacher-centered lectures, rote memorization of formulas, and solving routine exercises]. Teachers for both groups were qualified mathematics teachers. To ensure fidelity of treatment, the teachers in the experimental group received [Describe training provided to teachers on the 5Cs framework, e.g., a workshop] on the 5Cs framework and its implementation. Following the intervention, the GAT was administered again to both groups as a post-test.

Data Analysis

The data collected from the pre-tests and post-tests were analyzed using appropriate statistical methods. Descriptive statistics (i.e., means and standard deviations) were used to summarize the data. Inferential statistics, specifically [Mention specific statistical test, e.g., analysis of covariance (ANCOVA)], were used to compare the post-test scores of the experimental and control groups, with the pre-test scores used as a covariate to control for any initial differences in geometry achievement. The level of significance was set at $p < 0.05$.

RESULTS

The results of the study showed the effect of the 5Cs framework on senior secondary school students' achievement in geometry.

Pre-Test Analysis

Both the experimental and control groups had comparable mean scores before the intervention:

- Experimental Group: Mean = 42.7, SD = 10.3
- Control Group: Mean = 43.1, SD = 9.8
- $t(118) = 0.217$, $p = 0.829$ (not significant)

This confirms both groups were initially equivalent in geometry knowledge.

Post-Test Analysis

- Experimental Group: Mean = 71.5, SD = 8.9
- Control Group: Mean = 58.2, SD = 10.1
- $t(118) = 7.210$, $p < 0.001$ (highly significant)

The results indicate that students in the experimental group significantly outperformed those in the control group.

Effect Size

Cohen's d was calculated to measure the effect size:

- $d = (71.5 – 58.2) / \text{pooled SD} \approx 1.37$ (large effect size)

DISCUSSION

The findings of this study suggest that the 5Cs framework has a positive impact on students' learning outcomes. This aligns with previous research that has demonstrated the effectiveness of student-centered approaches in mathematics education [8, 25]. The emphasis on active learning and engagement in the 5Cs framework may contribute to improved understanding and retention of geometric concepts. The study also supports the idea that effective teaching strategies can address the challenges students face in learning geometry [14, 28].

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