



Effect of Concept Mapping Strategy on the Academic Achievement and Attitude of Upper Basic School Students in Geometry in Kwande Local Government Area, Benue State, Nigeria

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Abstract

This study explored the effectiveness of concept mapping strategies in enhancing academic performance and attitudes toward geometry among upper basic school students. The area of the study is Kwande Local Government, Benue State. Two research questions and two null hypotheses were involved. Quasi-experimental design involving pretest and posttest measures was used. The population includes 2400 upper basic II students. Purposive and simple random sampling techniques were employed to obtain 52 students from two public schools. Data collection was based on the Geometry Test (GT) and Geometry Attitude Scale (GAS). The instruments underwent validation through expert review by two educational professionals. The reliability coefficient of 0.75 was calculated for GT by using the Kuder-Richardson (KR-20) formula. The reliability coefficient of 0.82 was obtained for GAS by using Cronbach's Alpha. Descriptive statistics (mean and standard deviation) were used to address the research questions, while analysis of covariance (ANCOVA) was employed to test the hypotheses at a 0.05 significance level. Results showed that students who received teaching in geometry using concept mapping achieved higher mean scores than those who received teaching with traditional methods; students exposed to concept mapping demonstrated more positive attitudes toward geometry compared to their peers who received traditional instruction. The result recommends that teachers should apply concept mapping instructions for teaching geometry because it could change students' attitude positively and achieve higher. The conclusion indicates that concept mapping instructions should be encouraged for teaching geometry and science at all levels.

Key words: achievement, attitude, concept mapping, geometry and instructional strategy

Introduction

Mathematics education, particularly at the upper basic level, faces several challenges related to instructional strategies that hinder students' achievement. Geometry, being a branch of mathematics, is faced with similar challenges. This work seeks to address the effectiveness of the Concept Mapping Strategy (CMS) on students' achievement and attitude in geometry. The solution to these problems lies in the effective implementation of CMS in teaching geometry so as to help students visualise relationships between geometric concepts, theorems, and formulas. It can also be effective through analysing the impact of concept mapping on students' achievement, including the ability to solve problems and understand complex concepts.

Geometry is an area of mathematics that studies the shape of objects with their properties, such as lines, angles and points. It has numerous applications in many fields, including agriculture, engineering, arts, pharmacy, technology, health, aviation and business. Geometrical shape is either a plane or a solid. A plane geometrical shape has length and breadth. It is also called two-dimensional shapes because of the two straight lines that form it; Examples include triangle, rectangle, square, quadrilateral and kite. A solid shape has length, breadth and height; it is also called a three-dimensional shape because of the three straight lines that form it. Examples include cube, cuboid and cylinder. Students' positive attitude toward geometry can motivate achievement through concept mapping.

Concept mapping is a visual learning tool used by the teacher to organise and represent knowledge or concepts for students during teaching. It is an instructional strategy that has been widely recognised and used for the fast transmission of knowledge to the learner for easy understanding of complex concepts, including geometry. Adeyemi (2020) notes that CMS can guide students to organise and connect new information to their prior knowledge, which can lead to systematic application of skills for daily problems. Despite the potential benefits of concept mapping, there is every need to investigate its effectiveness for improving upper basic school students' achievement and attitude.

Achievement can be seen as the level of success or accomplishment of an affair, task or activity. Academically, it includes the application of knowledge, skills and ability that meets success or expectation at a given period of time. Oginni (2016) observes that students' academic achievement is often related in equal proportion to attitude since a positive attitude boosts interest and motivates achievement. The researchers observed that, the general public is worried about students' poor achievement in geometry especially at upper basic schools because, Akintade et al. (2024) report that students' consistently low scores in mathematics and geometry have become a widespread concern of every citizen, and this necessitate urgent efforts to address the issue by the government and stakeholders. Students are more likely to achieve better when appropriate teaching approaches are applied. The CMS has the potential to support better achievement/attitude and promote the application of learned skills in problem-solving. Geometry, by nature, demands a foundational understanding of technical drawing, logic, proofs, construction, moulding and computational skills. Therefore, mathematics teachers are encouraged to adopt suitable instructional strategies, such as CMS, to enhance students' understanding, improve achievement, and foster a positive attitude toward learning geometry.

Positive attitudes should be encouraged among students, as they can motivate the development of good character traits that enhance classroom participation and peer interaction. Chou and Tsai (2016) advise that mathematics teachers should foster positive attitudes in students, as this can help them develop strong character and achieve better outcomes in mathematics and science. There is a strong need to promote the use of concept mapping in teacher education, as it can help students appreciate mathematics through visual

representation and meaningful application of concepts, thereby increasing engagement during instruction. Conversely, low or negative attitudes can discourage learners from interacting with peers, family members, classmates, and individuals outside the school setting. Attitudes are largely driven by emotional responses and can influence anxiety levels, mental states, and personal behaviour either positively or negatively. Therefore, employing an appropriate instructional strategy, such as CMS, can help strengthen students' good character and engagement academically.

Literature Review

Instructional Strategy

An instructional strategy is a process in the form of demonstration with an appropriate teaching aid by the teacher to pass on knowledge to the learner in a classroom setting. According to Cañas and Novak (2011), an instructional strategy is a technique used to visually represent the relationships among ideas, concepts, and information. It includes processes and approaches that the teacher can apply to educate the learner in a given field. To this effect, Kurt (2020) notes that an *instructional strategy is a process where the teacher or an instructor can guide and educate the learner to build new knowledge and skills so as to achieve specific learning objectives*. Research reports that concept mapping could be a suitable instructional strategy that can engage students to love mathematics; it can also foster good character that can stimulate achievement because. A study by Kourkouli and Makri (2015) found that students who received instruction using concept mapping showed significant improvement in the achievement outcomes as compared to those who received instruction through the traditional teaching method. Hence, CMS can be used to present visual and physical representations of concepts and ideas for students to comprehend.

Achievement

Achievement simply refers to the level of success or accomplishment of a task or activity at the end of a specified period. It includes the degree of success attained by the learner at the end of the program. Audu et al. (2021) examined achievement as a systematic and purposeful quantification of learning outcomes to meet the targeted objectives. Understanding the mathematics achievement level of students is crucial for identifying areas where students may need additional support or enrichment. Gyuse and Yuda (2024) reported that students achieved better

outcomes when taught chemistry using CMS compared to those taught through the traditional or lecture method. Similarly, Kourkouli and Makri (2015) emphasised that effective teaching of mathematics by qualified teachers can motivate students to develop a positive attitude, which can stimulate their achievement. This underscores the close relationship between attitude and academic success.

Achievement is influenced by multiple factors. Gyuse and Yuda (2024) identified instructional strategies, student motivation, positive attitude, learning environment, and prior knowledge as key contributors to academic achievement. It was also observed that a good attitude encourages academic success. Gübbük and Uygün (2023) also affirmed that a positive attitude can motivate academic success, and vice versa. Regular analysis of students' achievements and attitudes is very important because it can educate teachers to adapt to effective instructional strategies that can promote positive attitudes and boost students' achievement in mathematics.

Attitude

Attitude refers to emotional feelings, discipline or beliefs of an individual that may influence the motive or engagement in a particular field, content or concept. It can also be viewed as beliefs or interests of an individual that give rise to opinions and feelings. Syieda (2016) observed that attitude is divided into three parts, such as: cognitive, behaviour and state of mind (feelings). These parts are related to each other. Among the students' factors, Calkin et al (2019) note that many researchers viewed attitude as a fundamental factor that promotes high or low achievement in trigonometry. This agrees with the theory of Fraser et al (1986) on attitude, which says that learners' personal and reasoning characters and the surrounding area can contribute to the thinking ability level, personality and the manner of approach that can influence learning outcomes. The review of this theory is of benefit to the current study since it provides fundamental background that supports the reasons behind attitude and achievement.

Attitude encourages achievement, and this could be the reason why (Syieda, 2016) observed that students can develop a positive or negative attitude within a given period of time, and high achievement can be observed from positive behaviour. Gyuse&Yuda (2024) investigated how CMS can influence students' results in chemistry; findings show that a good attitude produces good results and a bad attitude produces poor

results. The attitude of students is affected by many factors such as the family background, concentration, peer pressure, affection and beliefs, achievement, instructional strategy and the teacher (Calkin et al, 2019). Understanding students' attitudes (positively or negatively) is crucial for teachers because it can guide them to develop effective instructional strategies that can support good outcomes.

Most existing research, such as Gyuse&Yuda (2024), Gübbük&Uygün (2023) and Calkin et al (2019) on CMS had focused on other branches of science, mathematics and general problem-solving. Such studies neglected geometry, attitude and upper basic schools. The mentioned areas lack a specific investigative effect as regards CMS. However, this current study aims to address the existing research gaps by investigating how CMS can help students obtain better scores and good results in geometry and mathematics. It also tries to motivate students to build a good attitude in learning geometry, mathematics and science at upper-basic schools.

Research Questions

Research questions for the research work are:

1. What is the difference in mean scores of students who study geometry with CMS and those who study using the Traditional Instructional Method (TIM)?
2. What is the mean attitude score of students who study geometry using CMS?

Hypotheses

Hypotheses for the research work are:

- (i) There is no significant difference in the mean scores of students who study geometry using CMS and those who study using TIM.
- (ii) There is no significant difference in the mean attitude of students who study geometry using CMS and those who study using TIM.

Research Design

A quasi-experimental research design using a pretest-posttest control group format was adopted. Intact classes were used so that the school program could not be tampered with. Classes were allocated to either the experimental or control group at random. The experimental group received instruction with CMS, while the control group received instruction through the Traditional Instructional Method (TIM).

Population and Sampling

The population of the study includes 2,400 upper basic II students from 60 public upper basic schools. A purposive sampling technique was used to select two schools. Within each selected school, simple random sampling was employed to choose 26 students, yielding a total sample size of 52 students. The experimental group received teaching with CMS, while the control group also received instructions using TIM.

Instrumentation

Instruments for data collection were the Geometry Test (GT) and the Geometry Attitude Scale (GAS) developed by the researchers. The GT was a 20-item multiple-choice (options A–D) designed to assess students' achievement in plane geometry. It covered four topics: polygons, quadrilaterals, triangles, and circles. The GAS was a 20-item Likert-type scale aimed at measuring students' attitudes in geometry. Both GT and GAS, along with the lesson plans, were validated for content and face validity by two experts. The experts reviewed the instruments for clarity, language suitability, content relevance, and alignment with the research questions and hypotheses.

Reliability of Instruments

The GT and GAS were pilot-tested in different schools. The reliability of GT was calculated using Kuder-Richardson Formula 20 (KR-20), and a

reliability index of 0.75 was obtained. GAS was assessed for internal consistency using Cronbach's Alpha, yielding a reliability coefficient of 0.82. Regular mathematics teachers served as research assistants to help administer the instruments and collect the data.

Method of Data Collection

The two research instruments, the GT and the GAS, were first administered to all participants as a pretest to assess their prior knowledge and attitudes. Following the pretest, the experimental group received teaching using CMS, and the control group received instruction using the TIM. At the end of the intervention, the same instruments (GT and GAS) were administered to both groups to measure students' achievement and attitude in geometry. The instruction for both groups was delivered by the trained research assistants over a period of three weeks.

Data Analysis

Descriptive statistics, specifically, the mean and standard deviation, were used to answer the research questions. To test the null hypotheses, Analysis of Covariance (ANCOVA) was employed at the 0.05 level of significance. ANCOVA was chosen since it allows the researcher to statistically control for any differences between groups on the pretest scores, thereby improving the accuracy of comparisons on posttest outcomes.

Results

Table 1: Pre-test and post-test results

GROUP	N	PRE_TEST		POST_TEST		MEAN GAIN
		π	SD	π	SD	
EXPERIMENTAL	26	26.35	11.09	71.04	16.95	44.69
CONTROL	26	25.58	12.00	48.00	11.38	22.42

Results from Table 1 indicate that for the experimental group, the pre-test mean was 26.35, with a Standard Deviation (SD) of 11.09. Post-test mean was 71.04 (SD 16.95). This yielded a mean gain of 44.69, suggesting a substantial improvement in students' achievement after the treatment using the CMS. In contrast, the control group pre-test mean was 25.58 (SD

= 12.00) and post-test mean was 48.00 (SD = 11.38), giving a mean gain of 22.42. Although some improvement was recorded, the gain was significantly lower than that of the experimental group. These findings suggest that students taught using CMS demonstrated a greater improvement in geometry achievement compared to those taught using the TIM.

Hypothesis One: There is no significant difference in the mean scores of students who study geometry using CMS and those who study using TIM.

Table 2: Summary of ANCOVA showing the effect of CMS on students in geometry

Tests of Between-Subjects Effects					
Dependent Variable: POST_TEST					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6900.16	2	3450.08	16.22	0.01
Intercept	29342.64	1	29342.64	137.97	0.01
PRE_TEST	0.14	1	0.14	0.01	0.98
Group	6889.96	1	6889.96	32.40	0.01
Error	10420.82	49	212.67		
Total	201533.00	52			
Corrected Total	17320.98	51			

Table 2 indicates that $F(1, 49) = 32.40$; $P = 0.01 < 0.05$. So, the alternative hypothesis is retained. This result shows that students who received teaching

in geometry through CMS obtained higher mean scores than those who received instructions with TIM.

Table 3: Pre-test and post-test results

GROUP	N	PRE_TEST		POST_TEST		MEAN GAIN
		π	SD	π	SD	
EXPERIMENTAL	26	2.33	1.19	3.29	0.79	0.96
CONTROL	26	1.98	1.22	2.71	0.92	0.73

Results from Table 3 show that the experimental group's pre-test mean attitude score was 2.33 (SD), and the post-test mean was 3.29 (SD = 0.79). This resulted in a mean gain of 0.96, indicating a noticeable improvement in students' attitudes toward geometry after instruction using the CMS. Similarly, the control group pre-test mean score was 1.98 (SD =

1.22) and post-test mean score was 2.71 (SD = 0.92), yielding a mean gain of 0.73. This also indicates a positive shift in students' attitudes, though to a lesser extent compared to the experimental group. This shows great improvements in students' attitudes; the CMS was more effective in fostering positive attitudes for learning geometry.

Hypothesis Two: There is no significant difference in the mean attitude of students who study geometry using CMS and those who study using TIM.

Table 4: Results obtained from ANCOVA, which shows the attitude of students

Tests of Between-Subjects Effects					
Dependent Variable: POST_TEST2					
Source	Type III Sum of Squares	d.f	Mean Square	F	Sig.
Corrected Model	4.38	2	2.19	2.918	0.06
Intercept	109.77	1	109.77	146.21	0.00
PRE_TEST2	0.01	1	0.01	0.02	0.89
GROUP2	4.35	1	4.35	5.79	0.02
Error	36.79	49	0.75		
Total	508.03	52			
Corrected Total	41.17	51			

Table 4 reports that $F(1, 49) = 5.79$; $P = 0.02 < 0.05$. So the alternative hypothesis is retained. This implies that students who received instructions in geometry through CMS had higher mean scores in attitude (positive attitude) than those who received instructions with TIM.

Discussion of Findings

The current study tries to find out how CMS can assist students to achieve better and build a good attitude in geometry. Findings from hypothesis one show that students who received teaching in geometry with CMS achieved higher and better than those who received it with TIM; this implies that CMS is more effective for geometry teaching. This aligns with previous research of Iyekekpolor et al (2024), Gambari (2010), Akintade et al (2024), and Gyuse and Yuda (2024), whose findings revealed that students who received teaching with geometry instructions achieved better compared to those who received teaching with an ordinary teaching method. Other findings, such as Okafor and Akamobi (2020), Adeniyi and Lawal (2021), and Nwosu and Chukwu (2019) did not agree with this result. In their studies, findings show that students who received instructions in geometry, mathematics or science through concept mapping were found to achieve less compared to those who received teaching with traditional (lecture) methods. This implies that the traditional method is no longer giving positive results, meaning that CMS is to be encouraged in teaching geometry because it stimulates students to achieve better.

Findings from hypothesis two verify that the attitude of students on geometry changes from negative (before treatment) to positive (after treatment). This implies that students who received instructions in geometry using CMS developed a positive attitude after treatment compared to those who received instructions with TIM. This result supports earlier findings of Syamaun and Zakaria (2017), Calkin et al (2019), whose findings show that teaching mathematics with CMS encourages the learner to love mathematics and geometry and therefore achieves better. The findings of Adewale and Salami (2020) did not support this result. Their findings show that the concept mapping instructional strategy did not significantly improve students' attitudes toward mathematics as compared to the traditional instructional method. The achievement of students was good, but not because of the concept mapping instructions. These reports clearly show that CMS can motivate students to

build a positive attitude, which encourages them to achieve better.

Recommendations

This research work recommends that:

1. Teachers should employ CMS for teaching geometry and mathematics because it improves students' academic achievements.
2. Teachers should employ CMS for teaching geometry and mathematics because it was found to encourage a positive attitude in students.

Conclusion

The concept mapping instruction has the potential to enhance students' thinking skills, promote students' participation, and improve both interest and achievement in mathematics and science. By enabling students to engage in class engagement through CMS, CMS supports problem-solving, positive attitudes, encourages interest, appreciation for the subject and the application of knowledge to real-life situations, even beyond the school environment. It also encourages creativity and aligns with modern approaches to digital science education. In light of these benefits, it is recommended that mathematics and science teachers at all educational levels adopt CMS as a teaching strategy, particularly in subjects like geometry, to enhance students' understanding, motivation, and achievement.

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