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Effect of Origami Teaching Strategy on Students Attitude towards Geometry

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Abstract
This study investigates the effect of the origami teaching strategy on students' attitudes in geometry in secondary schools in Rivers State. Two hypotheses were formulated to guide the study. The study adopted a quasi-experimental design. Simple random sampling was used to collect a sample size of one hundred (100) SS2 students. The instrument for data collection was the Students' Attitudes towards Mathematics (SAM) survey, with a reliability index of 0.72. The t-test was used to test the hypotheses at a 5% significance level. The findings of the study revealed that students taught with the origami teaching strategy showed a more positive attitude towards geometry than the students taught without the origami teaching strategy. The findings also revealed that both male and female students exposed to the origami teaching strategy had an equal chance of developing positive attitudes towards the learning of geometry. It was recommended, among others, that the origami teaching strategy should be adopted in the teaching of geometry at the primary, secondary, and tertiary levels of education.

Keywords: Origami Teaching Strategy, Attitude, Geometry, Student Attitudes, Gender

Introduction

Origami is a term of Japanese origin that refers to the art of folding paper. The word 'Ori' denotes the action of folding, whereas 'kami' refers to the material of paper. Prior to the advent of origami, several terms were used to describe the practice of folding paper, such as "Orikata," "orisue," and "orimono." However, it was Friedrich Frobel, the creator of kindergartens, who introduced the use of small colored squares as educational tools for child development, which is now often referred to as folded paper. Origami has garnered global interest due to its evolving nature and incorporation of contemporary patterns and techniques. One of the techniques used in paper folding is wet folding, which involves making the paper more pliable during folding to enhance the ability of the final fold to maintain its shape. Origami is a mathematical practice that employs paper folding to demonstrate geometric patterns, formulas, and concepts. The integration of origami with Mathematics, particularly in the field of geometry, has proven to be highly beneficial in resolving previously insoluble issues that were resistant to traditional compass-based constructions. Tasks such as trisecting an arbitrary angle or constructing a double cube and straight-edge, which were once considered challenging, may now be effortlessly tackled through the utilization of paper folding techniques. Paper fold strips are a useful tool for solving polynomial equations of degree up to four.

Complex origami creations indeed necessitate the use of thin, sturdy paper or sheet foil to ensure precise folding. With a proficient understanding of origami techniques, one can precisely fold pieces of paper into various geometric forms and dimensions. A square can be folded into an equilateral triangle, pentagon, hexagon, and various rectangles. Moreover, attitudes evolve through firsthand experiences with objects, ideas, and events, as well as through social contact and socialization. Attitude is a crucial factor influencing both understanding and engagement in a particular work. It provides a guiding orientation for an individual's conduct and actions. An organism's behavior is influenced by its attitude, which can either lead it to approach a situation with a positive attitude or avoid it with a negative attitude. A positive attitude strengthens habits and contributes to their continuation, whereas a negative attitude weakens responses and ultimately leads to avoidance behaviors. Attitudes are not inherent but acquired, developed, and conditioned. They develop within society through diverse methods of education and instruction in the minds of individuals.

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Direct experience indeed plays a pivotal role in the development and expansion of attitudes. The attitudes of our parents, relatives, friends, teachers, students, peers, loved ones, and society at large are crucial in shaping an individual's attitude in a specific direction. Attitudes are formed through both direct and indirect factors. An attitude inherently carries a non-neutral stance, as it can manifest as either positive or negative, favorable or unfavorable, pleasant or unpleasant, and is often imbued with some form of emotion. In contrast, a neutral perspective is a viewpoint based on opinion rather than attitudes, devoid of any emotional tone. Attitudes possess varied degrees of efficacy, associated with sentiments such as pleasure, displeasure, fear, and love. They are long-lasting mental dispositions or persistent states of preparedness. Typically, attitudes are shaped and tend to be consistent and enduring, making them generally predictable. Attitude provides a guiding orientation for one's conduct and actions. An organism's behavior is influenced by its attitude, causing it to either approach a situation with a positive attitude or avoid it with a negative attitude. A positive attitude strengthens habits and contributes to their continuation, while a negative attitude weakens responses and ultimately leads to avoidance behaviors. Attitudes are not inherent but acquired, developed, and influenced. They develop within society through diverse methods of education and instruction in the minds of individuals. Attitudes emerge from our direct and indirect encounters with objects, ideas, and circumstances, as well as through the process of interaction and socialization with others.

Attitudes are formed through both direct and indirect factors. An attitude is inherently non-neutral, as it might manifest as positive or negative, favorable or unfavorable, pleasant or unpleasant, and is imbued with some form of emotion. A neutral perspective is a viewpoint based on opinion rather than attitudes, lacking any emotional tone. Attitudes possess varied degrees of effectiveness and are associated with emotions such as pleasantness, unpleasantness, fear, and love. They refer to relatively stable and persistent mental states or dispositions, typically created and consistent, making them predictable. The cognitive aspect that emerges during the perceptual phase results in attitudes that are relatively enduring. The premise that attitudes are acquired through learning suggests they can be altered through further learning or experience. They have the ability to be enhanced or diminished and can transition from being enjoyable to unpleasant or from advantageous to disadvantageous, and vice versa. Attitudes can be altered based on situations, experiences, and the way knowledge is received, whether through different communication methods or direct encounters with the origami teaching style. An attitude is an evaluative stance directed towards the social world, typically assessed using a five or six-point scale, such as very favorable, favorable, unfavorable, extremely unfavorable, and moderately favorable. It consists of cognitive, emotional, and behavioral components. The cognitive component highlights an individual's understanding and awareness of an attitude, while the affective component refers to emotional feelings towards objects of attitudes (e.g., Snakes bite, as demonstrated in this example. Snakes are frightening).

The behavioral component refers to the observable actions and behaviors exhibited by a person when they are exposed to a certain object. For instance, an individual emits a loud vocalization in response to the sight of an arachnid. Attitudes are not genetically inherited but rather constructed via ongoing experiences with our environment. From the moment of birth, every person is exposed to stimuli from the environment, either directly or indirectly, which instructs them to adopt specific ideas, values, and beliefs. The emergence of attitudes is a result of social tradition, learning, and social institutions. In the field of social psychology, three significant learning theories have been identified: classical conditioning, operant conditioning, and observational learning. The process of attachment involves incorporating a new behavior into an established pattern, which amplifies two stimuli to produce another informed response in an individual. Classical conditioning comprises three prominent phases: prior to the conditioning, during the process of shaping, and following the process of shaping.

In 1938, Skinner introduced the concept of operant conditioning, which involves modifying behavior by providing reinforcement, whether positive or negative, following the desired response. Thorndike (1905) proposed the law of effect, which states that reinforced behaviors are more likely to occur again, while behaviors that are not reinforced are less likely to occur again. Observational learning involves observing, remembering, and imitating behaviors observed from a model. Bandura (1925) posited that humans have a higher level of intellectual capacity compared to other animals. Unlike other organisms, people are more likely to contemplate the links between their behavior and the resulting consequences. Furthermore, humans are more susceptible to the effects of their beliefs about future events rather than being solely driven by actual experiences.

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The majority of secondary school pupils in this country perceive Mathematics as challenging and abstract, likely due to their struggles in comprehending and applying the Mathematical principles presented in the classroom. Several reasons contribute to underperformance in secondary school Mathematics, including ineffective teaching methods, a negative attitude towards Mathematics, and a lack of quality instructional materials for Mathematics. Analyzing the attitudes of students towards Mathematics based on gender is crucial, focusing on the aims, substance, techniques, and evaluation of the Mathematics curriculum. In Kenya, Manoah et al. (2011) conducted a study on the 'Influence of Attitude on Performance of Students in Mathematics Curriculum.' The study utilized stratified random sampling to obtain a sample size of 986 pupils. The research employed the Students' Questionnaire (SQ) and Mathematics Test (MT) as instruments, employing a quasi-experimental approach. The survey found that both girls and boys had indifferent opinions regarding the Mathematics curriculum. Several factors contribute to subpar performance in secondary school Mathematics achievement. These include insufficient teaching methods, lack of enthusiasm towards Mathematics, and a shortage of suitable instructional resources for teaching Mathematics across all educational levels (Obi et al., 2014). Additionally, Michael (2011) conducted a study on 'A Survey of Factors Responsible for Students' Poor Performance in Mathematics in Senior Secondary School Certificate Examination' in Kogi State, utilizing a simple random sample method. The study validated that the teacher's influence, students' attitudes and commitments, teaching methods, use of instructional materials, and school environment significantly contribute to students' underperformance in Mathematics in the senior secondary school certificate examination.

The WAEC Chief Examiners' report (2016-2022) on the annual results of secondary school pupils reveals a highly disappointing performance of students in Mathematics. An analysis of students' performance in Mathematics in both external and internal examinations indicates that only in the years 2004 and 2012 to 2021 did more than 50% of students achieve a passing grade in Mathematics, according to the analysis of WASSCE Mathematics Results from 1991 to 2021. In previous years, performances were consistently less than 50%, indicating subpar performance, which served as the basis for this study. Mathematics is the central component of both science and technology, and its significance in these fields cannot be overstated. The use of science, technology, and business organization is essential for the functioning of any area, and the level of competition among countries in these areas is contingent upon their technological proficiency. Proficiency in mathematics is thus crucial for technological competency. Without a strong foundation in mathematics, there will be deficiencies in technological advancement, leading to a sluggish pace of economic growth in countries. The inquiry pertains to the underlying reasons for the lack of success in Mathematics within this nation, as well as the methods by which performance in terms of both achievement and attitude towards Mathematics might be enhanced.

The underperformance of pupils in Mathematics may be attributed to several factors, including their negative attitude towards concepts, inadequate instructional materials for teaching Mathematics, absence of a Mathematics laboratory, and ineffective and outdated teaching methods. The findings of Gambari et al. (2014) validate that geometry, being an abstract component of Mathematics, poses challenges for pupils in terms of learning. Many educators face challenges when attempting to instruct without the use of instructional tools. Instructional models have a significant impact on students' attitudes towards developing an interest in Mathematics, which in turn affects their academic results and ability to retain knowledge. Considering this, it is evident that instructional models can assist students in retaining information taught in Mathematics. The findings of Obi et al. (2014) indicate that using origami as an instructional approach or material has a beneficial impact on students' ability to retain information. All of these factors suggest that instructional materials can have an impact on both the achievement and retention of Mathematics. Hence, it is essential to utilize origami as an educational exercise that can positively impact students' attitudes towards geometry. Therefore, the objective of this study is to determine the impact of employing the origami teaching approach on students' disposition towards geometry.

Statement of the Problem

It is a well-known fact that the subject of mathematics affects all aspects of human life, and that the social, economic, scientific, and technological aspects of humanity are centered on numbers. Being the basic skill that underlies all scientific and technological skills, mathematics is generally seen as the language of most branches of science and technology. It is closely related to other school subjects that deal with numeration, variation, graphs, fractions, logarithms, and indices, algebraic processes, solution of equations, as well as areas and volume computations.

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Expectedly, a sound background in basic mathematical principles has become a precondition for progression to tertiary education and thus one of the key requirements for gainful professional employment. Among the other branches of mathematics, mensuration, which comprises geometrical and trigonometric concepts of the Senior Secondary School (SSS) Mathematics Curriculum, represents the most difficult area (Kurumeh, 2006; Chief examiner's report, 2006). Even though varieties of instructional techniques have been adopted by teachers to improve students' attitudes in mathematics (Ogbonna, 2004), very few of these appear to have focused on the teaching of geometry (Jones & Tzekaki, 2016). Helpful as these measures may be, they have not proved to be effective for the improvement of students' attitudes in mathematics, precisely geometry (Akın & Cancan, 2007). According to Boakes (2009), origami is the art of paper folding and effective mathematics teaching tools. Therefore, there is a need to explore the effectiveness of other alternative instructional strategies, such as origami, in the improvement of students' attitudes in geometry. Therefore, the problem of the study is: How could the use of Origami Teaching Strategy enhance students' attitudes towards geometry?

Aim and Objectives of the Study

This study investigated the effect of origami teaching strategy on students' attitudes towards geometry in secondary schools in Rivers State. Specifically, the objectives are to:

1. Determine the difference in attitudes towards geometry between students exposed to origami teaching strategy and those taught without origami teaching strategy.
2. Find out the difference in attitudes towards geometry between the male and female students exposed to origami teaching strategy

Hypotheses

H_{01}: There is no significant difference in attitudes towards geometry between students exposed to origami teaching strategy and those taught without origami teaching strategy.

H_{02}: There is no significant difference in attitudes towards geometry between the male and female students exposed to origami teaching strategy

Methodology

The study design employed is the quasi-experimental design. The attitude is the dependent variable, while the origami instruction approach is the independent variable. The study included a population all the senior secondary schools. The purposive sampling methodology was employed to choose five schools for this study. From these five schools, a simple random sampling method was utilized to gather a total of twenty (20) students from each school, resulting in a sample size of one hundred (100) students. A sample size of 100 senior secondary school two (SS2) students was randomly selected from five secondary schools for this study. The data gathering instrument used was the Students Attitudes towards Mathematics (SAM) survey. The face and content validity of the Students Attitudes towards Mathematics (SAM) was confirmed by two experts. The reliability test yielded a value of 0.72, indicating a reliable result. The mean was utilized to address the research question while a t-test was employed to test the hypotheses at a 5% level of significance.

H_{01}: There is no significant difference in attitudes towards geometry between students exposed to origami teaching strategy and those taught without origami teaching strategy.

Table 1: t-test on the difference in the attitude towards geometry between students taught using OTS and those taught without OTS.

	N	Mean	SD	t-cal	Df	t-crit.	Decision
Control	48	2.04	1.02	24.06	98	1.960	Reject H01
Experimental	52	3.80	1.7				

The results indicate that the mean attitude towards geometry for the control group was 2.04 with a standard deviation of 1.02, while for the experimental group, the mean was 3.80 with a standard deviation of 1.7. The calculated t-value

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was 24.06, with 98 degrees of freedom. Comparing this to the critical t-value (1.960) at 0.05 significance level, it surpasses it significantly, leading to the rejection of the null hypothesis. In other words, the data suggest a significant difference in attitudes towards geometry between students taught using the origami teaching strategy and those taught without it. The group exposed to the origami teaching strategy exhibited a notably higher mean attitude towards geometry compared to the group without it.

H_{02}: There is no significant difference in attitudes towards geometry between the male and female students exposed to origami teaching strategy

Table 2: t-test on the difference in the attitude towards geometry between the male and female students taught using OTS

Gender	N	Mean	SD	t-cal.	Df	t-crit.	Decision
Male	27	2.80	1.10				
				1.819	50	1.960	Retain H02
Female	25	2.70	0.90				

Table 2 presents the results of a t-test examining the difference in attitudes towards geometry between male and female students who were taught using the origami teaching strategy (OTS). For male students, the mean attitude towards geometry was 2.80 with a standard deviation of 1.10. Female students had a mean attitude of 2.7 with a standard deviation of 0.9. The calculated t-value was 1.819, with 50 degrees of freedom. Comparing this to the critical t-value (1.960) at a 0.05 significance level, the calculated t-value does not exceed the critical value, leading to the acceptance of the null hypothesis. In essence, the results suggest that there is no significant difference in attitudes towards geometry between male and female students who were taught using the origami teaching strategy. Both genders exhibited similar mean attitudes towards geometry in this context

Discussion

The results from Table 1 indicate that students who were instructed using origami displayed a more favorable disposition towards geometry compared to students who were taught using a traditional approach. The results of this study align with the findings of Sukran et al. (2015), and Hakki (2016), who demonstrated that using origami-based instruction and creative teaching methods in mathematics leads to improved mathematics achievement and a positive attitude towards the subject. The findings align with the views of Bandura (1997), who suggested that individuals are more likely to adopt an observed behavior if it leads to outcomes they value. Additionally, it is suggested that learners should engage in seeing and experiencing activities, actively reflect on their experiences, and apply theoretical knowledge.

The results from Table 2 indicate that male students had a slightly more positive attitude than female students. However, both male and female students who were exposed to the origami teaching strategy had an equal likelihood of developing positive attitudes towards learning geometry concepts taught with this strategy. This study aligns with the findings of Manoah et al. (2011), who discovered that both boys and girls had a neutral attitude towards the mathematics curriculum.

Conclusion

These findings demonstrated that students who were taught using the origami teaching approach exhibited a more favorable disposition towards geometry compared to those who were not taught using this strategy. The results also indicated that both male and female students who were exposed to the origami teaching approach had an equal likelihood of developing positive attitudes towards learning geometry.

Recommendations

According to the findings, the following recommendations were made:

(1) The origami teaching strategy should be adopted in the teaching of geometry (Mathematics) at the primary, secondary, and tertiary levels of education.

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(2) Seminars, workshops, and conferences should be organized by professional bodies, federal, and state Ministries of Education on how the origami teaching strategy can be effectively utilized by mathematics teachers, students, and others in the teaching and learning of Mathematics.
(3) Since the origami teaching strategy is not gender biased, it should be employed to eliminate gender discrepancies.

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