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Effects of Kumon and Framing Teaching Strategies on Secondary School Students' Achievement in Mathematics in Delta-South Education Zone, Delta State

OKIGBO, Ebele Chinelo
Department of Science Education, Nnamdi Azikiwe University, Awka, Nigeria
Email: ec.okigbo@unizik,edu.ng
Phone Number: +2348037715662

PEREKEME, Peresuode
Department of Mathematics, College of Education, Warri, Delta State, Nigeria
Email: princepppk1980@gmail.com.
Phone Number: +2348135071027
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Abstract
The research examined the effect of Kumon and framing teaching strategies on the mathematical performance of secondary school students in the Delta-South Education Zone, Delta State, Nigeria. The study population comprised 19,201 Senior Secondary Two (SS2) students within the Zone. The study utilized a sample size of 286 SSII students, randomly chosen from six intact classes in public mixed schools. The data collection instrument employed was the Mathematics Achievement Test (MAT), which received validation from four experts. The reliability of the MAT was determined using the Kuder-Richardson Formula 20, resulting in a coefficient of 0.86. The intervention entailed presenting the mathematics topics to the experimental groups through Kumon and framing teaching strategies, whereas the control group received instruction via expository teaching strategy (ETS). A pretest was conducted prior to the treatment, followed by a post-test subsequent to the treatment. The collected scores were analysed using mean and ANCOVA at a 0.05 alpha level. The results indicated that Kumon and framing teaching strategies significantly enhance students' mathematical achievement compared to expository teaching strategy. Furthermore, there was no significant disparity in the average accomplishment scores of male and female students instructed in mathematics by Kumon, framing, or expository teaching strategies, among other observations. The research concluded that both Kumon and framing teaching strategies were effective in enhancing the mathematical performance of high school students in the Delta-South Education Zone. It was recommended that secondary school mathematics educators integrate and amalgamate Kumon and frame teaching strategies into their curriculum.

Keywords: *Kumon and framing teaching strategies, mathematics achievement, secondary school, Delta State*

Introduction

Mathematics is the discipline that examines quality, structure, space, and change. It entails the formulation of conjectures and the establishment of truths using rigorous logical reasoning based on axioms and definitions. The phrase derives from the Greek word "mathema," signifying "that which is learned" or "subject of instruction." Mathematics originated with the Egyptians, Babylonians, and Greeks (Ijeh, 2022). Mathematics is crucial for the study of engineering, radiography, medicine, pharmacology, architecture, surveying, and other applied fields. A robust understanding of mathematics enables individuals to appreciate the complexity and beauty of nature (Oduolowu, 2017). Consequently, Nigeria's educational system requires a comprehensive and pertinent mathematics curriculum. Mathematics encompasses statistics, algebra, geometry, and calculus, areas in which students frequently encounter difficulties during instruction. Recent reports from the WAEC Mathematics Chief Examiner indicate that students fail to approach statistical questions with scientific rigor. Ijeh (2014) previously noted that mathematics students consistently underperform in external assessments such as the Senior School Certificate Examinations (SSCE).

Over the past seven years, a significant proportion of Delta State students have attained scores between D7 and F9, indicating failure in WAEC Mathematics examinations. Specifically, from 2016 to 2022, 42.60% to 47.04% of students received grades A1 to C6, while those scoring D7 to F9 consistently exceeded 50%, peaking at 59.10% in 2021. The persistent low performance underscores the need for effective pedagogical strategies such as Kumon and framing. These strategies could enhance students' mathematical understanding and performance, thereby reducing WAEC failure rates, likely due to their phased learning structure.

Teachers' teaching method shape students' views about mathematics. However, one of the widely used teaching method is the expository teaching that involves instructors speaking to students. Expository teaching is "talk-chalk" according to Ajaja (2016). The author says expository teaching works in any size class, but it's most prevalent in larger ones. Teachers use expository teaching because it helps them cover subject matter in a short time. The expository teaching strategy uses a teacher-centered instructional model in which the instructor is an authoritative person who teaches students, who have little or no input in the learning process. Expository teaching covers the course syllabus quickly, but it encourages rote memorisation and reproduction rather than critical analysis and integration. Simply put, expository teaching may not help children learn and retain mathematics concept taught. Since children are less active during expository education, it may contribute to their poor mathematics performance.

Modern instructional strategies that could promote active involvement, critical thinking, and practical application have become increasingly popular in recent times. These strategies attempt to improve students' higher-order cognitive skills and prepare them for real-world situations. Educational specialists must recognise the necessity for such teaching strategies that improve students' cognitive, emotional, and psychomotor learning. Ejelue (2017) suggests changing the teaching paradigm by making students more involved in learning so they can grasp learning materials. Kumon teaching is one of the active teaching strategies. Japanese pedagogy Kumon

aims to maximise each students' learning potential. The outcome is contingent upon students' self-directed learning, concentration, study practices, self-assurance, and academic self-worth. The Kumon teaching strategy seeks to identify and cultivate children's learning potential through individualised instruction, maximise learning opportunities for numerous students, recognise its societal benefits, and enhance student competence by improving instructional materials and guidance practices.

The Kumon methodology prioritizes self-directed learning through the practice and mastery of fundamental skills, particularly in mathematics and reading. Educators can implement the Kumon Teaching Strategy (KTS) by developing personalized learning plans for students, enabling them to progress at their own pace, integrating gradual challenges to enhance prior knowledge without causing undue stress, and designating time for autonomous practice. The KTS encompasses the organization and presentation of information to facilitate learning and retention, akin to framing. Nonetheless, while KTS underscores self-learning, the framing teaching strategy promotes active engagement and self-evaluation.

Framing Teaching Strategy (FTS) is a visual configuration that organizes extensive information into a grid, matrix, or framework, offering explicit directions and exemplars to enhance student achievement (Nnamani & Oyibe, 2016). Instructional design influences student motivation and engagement. Clear and meaningful instructions encourage students to learn and participate actively. Precise instructions help students comprehend the purpose and significance of tasks, fostering effort and concentration. Frames display fundamental concepts in rows and columns, permitting the inclusion of additional information in 'slots' such as facts, examples, descriptions, explanations, processes, and procedures to clarify their interconnections.

McKenzie (2000) provided instructional designers with six features of framing teaching techniques for project-based instructional plans applicable in both electronic and classroom environments. Framing elucidates purpose, evaluates expectations, directs students to valuable resources, minimizes wasted time, alleviates uncertainty, surprise, and disappointment, mitigates boredom and irrelevant materials, and focuses energy to generate momentum. Various models of framing teaching are available. This study employed Djwantoro (2010)'s six-step methodology, which encompasses introduction, content development, hands-on activities, class discussion, and evaluation, due to its simplicity and systematic classroom implementation.

Kumon and framing teaching practices encourage teacher-student conversation, which helps students achieve goals they couldn't without it (Himawati and Hanif, 2013). This study examines the effect of Kumon and framing teaching strategies in improving mathematics achievement among students in Delta-South Education Zone in Delta State. Achievement involves completing a task and students attain success by effort, skill, practice, or tenacity. Someone generally achieves with effort (Nneji, 2010). This study defines achievement as students' academic performance following a course. Mathematics achievement measures how well students do in a mathematics activity or test. Mathematics Achievement Test is used to measure achievement in this study. Thus, mathematics achievement may not occur unless teachers lay a firm foundation for learning through well-planned lessons and activity-based teaching. This will improve math achievement, retention, and mastery. There is little unanimity on how instructional tactics affect students' achievement

based on gender. The effects of learner-centred activity-oriented strategies like Kumon and framing teaching strategies on male and female student achievement therefore need to be investigated.

Gender is a psychological construct that delineates male and female. Oribhabor (2019) asserts that society perpetually formulates psychological and cultural terminology to differentiate male and female roles, behaviors, and emotional and mental characteristics. John, Benjamin, and Imoko (2015) indicate that scholars, policymakers, and practitioners agree on the socially constructed gender disparities and their significant impacts on individuals' lives. Research on gender differences in mathematical achievement yields inconclusive results. Ajai and Imoko (2015) employed problem-based learning to evaluate gender differences in mathematics achievement and retention, concluding no significant disparity between male and female PBL algebra students. Conversely, Kwame, McCarthy, McCarthy, and Gyan (2015) discovered that girls in mixed-sex schools outperformed boys in elective mathematics. Given these inconsistent findings, the relationship between gender and mathematics achievement remains variable, necessitating ongoing investigation.

Statement of the Problem

Despite the significant role of mathematics in science and related fields, students' performance in mathematics, including its branch Statistics, during the Senior Secondary School Certificate Examinations (SSCE) has persistently been inadequate. This dismal achievement can be attributed to educators employing unsuitable strategies in teaching mathematical concepts. Many instructors rely on expository teaching strategies that often lack active student engagement, resulting in poor retention and substandard performance. Nevertheless, researchers are actively seeking solutions to the ongoing failure rates among mathematics students. One such initiative involves the implementation of learner-centered instructional strategies, such as Kumon and framing teaching techniques, aimed at fostering deeper learning through group collaboration, social interaction, and support from peers, educators, and resources.

The inquiry pertains to whether modifications in instructional strategies could address the issue of inadequate academic performance in mathematics among students. The primary question is: Can the implementation of learner-centered teaching strategies improve the academic achievement of students in mathematics? This question underpins the researcher's motivation. Consequently, this study aimed to examine the effects of Kumon and framing teaching strategies on the achievement in mathematics within the Delta-South Education Zone of Delta State, Nigeria.

Purpose of the Study

The objective of this study was to assess the impact of Kumon and Framing teaching strategies on the mathematical achievement of senior secondary school students. Specifically, the study aimed to ascertain the:

1. Average achievement scores of students instructed in mathematics by the Kumon teaching technique (KTS), Framing teaching strategy (FTS), and Expository teaching strategy (ETS).
2. Average achievement scores of male and female students instructed in mathematics via KTS, FTS, and ETS strategies.

Research Questions

The subsequent research inquiries directed the investigation:

1. What are the average achievement scores of students instructed in mathematics by the Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS), and Expository Teaching Strategy (ETS)?
2. What are the average achievement scores of male and female students instructed in mathematics using KTS, FTS, and ETS?

Hypotheses

The subsequent null hypotheses were evaluated at a significance level of 0.05:

1. There is no substantial difference in the average accomplishment scores of students instructed in mathematics using the Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS), and those taught with the Expository Teaching Strategy (TTS).
2. No substantial difference exists in the average achievement scores of male and female students instructed in mathematics by KTS, FTS, and those taught via ETS.

Methodology

This research employed a quasi-experimental, non-randomized pretest-posttest control group design. This strategy was required due to the school authorities' unwillingness to allow random assignment of participants, since it would interfere with their instructional timetable and class structure. Intact courses were randomly assigned to two experimental groups and one control group. The independent factors comprised teaching strategies, whereas the dependent variables were the mathematics achievement scores of students. The study population consisted of 19,201 senior secondary two (SS2) students in the Delta-South Education Zone of Delta State, Nigeria, including 14,895 males and 4,306 females. A sample of 286 SS2 students was obtained using simple random sampling from six co-educational secondary schools, constituting the sample size for this study.

The research utilised the Mathematics Achievement Test (MAT) for data acquisition. The face validity of the MAT was evaluated by four specialists in diverse fields of Science Education and Instrumentation. The panel consisted of an expert from the Science Education department at Nnamdi Azikiwe University, Awka; a specialist from the Mathematics Department at the College of Education, Warri; a professional in Measurement and Evaluation at Nnamdi Azikiwe University, Awka; and an experienced mathematics educator from Essi College, Warri. The internal consistency reliability of the MAT was assessed using a sample of 50 students from a school in Burutu Local Government Area of Delta State, which possesses comparable features to the sampled institutions. The reliability coefficient of the MAT was determined to be 0.86 via the Kuder-Richardson formula 20, signifying that the MAT items were dependable. The intervention involved training students in the two experimental groups using Kumon and organised teaching tactics, whereas the control group was taught through an explanatory teaching strategy. The MAT was conducted as a pre-test and post-test for both the experimental and control groups before and after the intervention. The pre-test and post-test data were analysed via mean and analysis of covariance. The hypothesis determination rule states that the null hypothesis is rejected when the probability value is less than or equal to the significance level of 0.05 ($p \leq 0.05$); conversely, if $p > 0.05$, the null hypothesis is not rejected.

Results

Table 1: Mean of Pre-test and Post-test Achievement Scores of Students Instructed in Mathematics Utilizing Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS), and Expository Teaching Strategy (ETS)

Group	n	Pre-test		Posttest		Mean Gain
		Mean	SD	Mean	SD	
KTS	96	27.73	5.97	67.52	9.58	39.79
FTS	90	27.23	5.87	61.14	10.70	33.91
ETS	100	29.90	5.96	58.44	7.89	28.54

The data in Table 1 indicates that students in KTS, FTS, and ETS achieved mean gains of 39.79, 33.91, and 28.54, respectively. This suggests that the interventions utilizing KTS, FTS, and ETS positively influenced students' mean achievement scores in mathematics, with the KTS group exhibiting the highest mean gain of 39.79.

Table 2: Mean of Pre-test and Post-test Achievement Scores of Male and Female Students Instructed in Mathematics Utilizing KTS, FTS, and ETS

Group	Gender	n	Pre-test		Posttest		Mean Gain
			Mean	SD	Mean	SD	
KTS	Male	46	26.74	6.55	67.39	9.50	40.65
	Female	50	28.64	5.28	67.64	9.75	39.00
FTS	Male	47	25.81	6.06	65.91	9.24	40.10
	Female	43	28.79	5.29	64.67	11.16	35.88
ETS	Male	42	30.81	5.07	59.05	8.86	28.24
	Female	58	29.24	6.47	58.00	7.16	28.76

Table 2 indicates that KTS influences male and female students' mean achievement scores in mathematics with effects of 40.65 and 39.00, respectively, while FTS affects these scores with values of 40.10 for males and 35.88 for females, and ETS yields effects of 28.24 for males and 28.76 for females.

Table 3: ANCOVA on the Variance in Mean Achievement Scores of Students Instructed in Mathematics via KTS, FTS, and ETS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4309.789[a]	3	1436.596	16.214	.000
Intercept	42571.767	1	42571.767	480.473	.000
Pretest	83.409	1	83.409	.941	.333
Strategy	4308.448	2	2154.224	24.313	.000
Error	24986.312	282	88.604		
Total	1140741.000	286			
Corrected Total	29296.101	285			

Table 3 reveals a P-value of 0.333 in the pretest, indicating that the three groups are comparable. Furthermore, at a significance level of 0.05, with 2 degrees of freedom in the

numerator and 282 in the denominator, the computed F-value is 24.313, and the P-value of 0.000 is below 0.05. Thus, the null hypothesis is rejected, signifying a substantial difference in the mean achievement scores of children instructed in mathematics by KTS, FTS, and ETS. A Scheffe Post-Hoc Analysis was conducted to determine the nature of these discrepancies, as outlined in Table 4.

Table 4: Scheffé Post-Hoc Analysis of Mean Difference Significance in Achievement Among the Three Groups

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
KTS	FTS	6.331*	1.382	.000	3.611	9.051
	ETS	9.280*	1.361	.000	6.602	11.958
FTS	KTS	-6.331*	1.382	.000	-9.051	-3.611
	ETS	2.949*	1.391	.035	.211	5.686
ETS	KTS	-9.280*	1.361	.000	-11.958	-6.602
	FTS	-2.949*	1.391	.035	-5.686	-.211

The results in Table 5 indicate that the differences in direction favor KTS, followed by FTS. This suggests that KTS most significantly improved students' achievement in mathematics, with FTS following closely.

Table 6: Table 6: ANCOVA on Gender Differences in Mean Achievement Scores of Students Taught Mathematics Using KTS, FTS, and ETS

Groups	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
KTS	Corrected Model	110.680[a]	2	55.340	.598	.552
	Intercept	21649.695	1	21649.695	233.921	.000
	Pretest	109.198	1	109.198	1.180	.280
	Gender	8.258	1	8.258	.089	.766
	Error	8607.278	93	92.551		
	Total	446388.000	96			
	Corrected Total	8717.958	95			
FTS	Corrected Model	1026.262[a]	2	513.131	4.873	.010
	Intercept	13752.918	1	13752.918	130.610	.000
	Pretest	.241	1	.241	.002	.962
	Gender	951.490	1	951.490	1.036	.063
	Error	9160.860	87	105.297		
	Total	346665.000	90			
	Corrected Total	10187.122	89			

ETS	Corrected Model	306.212[a]	2	153.106	2.535	.085
	Intercept	9164.523	1	9164.523	151.740	.000
	Pretest	279.477	1	279.477	4.627	.034
	Gender	8.636	1	8.636	.143	.706
	Error	5858.428	97	60.396		
	Total	347688.000	100			
	Corrected Total	6164.640	99			

Table 6 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 93 degrees of freedom in the denominator, the calculated F-value is 0.089, with a P-value of 0.766, which surpasses 0.05. Thus, there is no significant difference in the average achievement scores of male and female students taught mathematics using KTS. Table 6 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 87 degrees of freedom in the denominator, the calculated F-value is 1.036, with a corresponding P-value of 0.063, which surpasses 0.05. Therefore, there is no significant difference in the average achievement scores of male and female students taught mathematics with FTS. Table 6 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 97 degrees of freedom in the denominator, the calculated F-value is 0.143 and the P-value is 0.706, which surpasses 0.05. Thus, there is no significant difference in the average achievement scores of male and female students taught mathematics using ETS. As a result, the null hypothesis is dismissed. Thus, there is no significant difference in the average accomplishment scores of male and female students taught mathematics by KTS, FTS, and those instructed using ETS. This suggests that KTS, FTS, and ETS equally enhanced the mathematical ability of both male and female students.

Discussion

The study demonstrated that students instructed in mathematics with KTS attained considerably greater achievement levels compared to those taught via FTS. The favourable outcome for KTS is attributed to its instructional stages, which provided students with enhanced contact with the learning content and greater individual accountability for their education. This study's findings align with those of Ashraf (2018), who reported that KTS enhanced students' performance in mathematics and other disciplines. The study's findings indicated that students instructed in mathematics through KTS achieved much higher scores than those taught by ETS. KTS emphasises personalised learning programs for each student, enabling them to study at their own speed and fully comprehend ideas before to progressing to more complex subjects. This tailored approach may have resulted in an enhanced comprehension of mathematical ideas. This finding supports Sunarsih's (2022) conclusion that the Kumon teaching technique is more effective for instructing multiplication to grade IV students at SD Lanjan 01 than the ETS method. The study's findings indicated that students instructed in mathematics using FTS achieved much higher scores than those taught by ETS. This observation may result from the framing teaching technique, which likely engaged students more effectively by contextualising mathematical concepts in real-world scenarios, hence enhancing the material's relevance and appeal. This discovery supports Miriogu's

(2012) conclusion that the framing teaching technique significantly improved students' performance and retention in mathematics compared to the expository teaching strategy.

The study's results revealed no significant disparity in the average success scores of male and female students taught mathematics with KTS. This suggests that male and female students taught mathematics via KTS achieved similar performance levels. This result may be ascribed to uniform participation. Male and female students participated equally in the Kumon learning sessions, contributing to and obtaining knowledge uniformly. This finding supports Ashraf's (2018) assertion that KTS is equally advantageous for teaching mathematics to both male and female students. The study again shown no significant difference between the average achievement scores of male and female students taught mathematics using the frame teaching strategy (FTS). This is evidenced by the equal participation of both male and female students throughout training employing the framing teaching style. This data supports the findings of Alhassan, Hassan, Gimba, and Mohammed (2022), which demonstrate no significant difference in the mean achievement scores of male and female students taught trigonometry using FTS. The study revealed no significant difference between the average achievement scores of male and female students taught mathematics using ETS. This suggests that both male and female students taught mathematics by the expository method had similar outcomes on the assessment. This may be attributed to the inclination of both male and female students to passively listen to their teachers during lessons. Furthermore, it is likely that both male and female students in the study have similar learning preferences that facilitate the ETS, leading to comparable results for both groups. This finding corresponds with the study of Ogoke and Okigbo (2021), which shown that gender does not significantly influence the average achievement and retention scores of students taught mathematics using the expository teaching method.

Conclusion

The research indicated that KTS significantly outperformed FTS in improving students' mathematical achievement. Additionally, FTS significantly outperformed ETS in improving mathematics achievement. Consequently, the study concluded that KTS is the most effective teaching strategy for enhancing students' achievement in mathematics relative to FTS and ETS.

Recommendations

The subsequent recommendations are derived from the study's findings:

1. Secondary school mathematics educators ought to implement and incorporate KTS in the instruction and comprehension of mathematics.
2. School administrators should organize seminars and workshops on the adoption and utilization of KTS in mathematics education.
3. Mathematics educators should employ FTS as an alternative pedagogical technique when KTS is impractical.

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