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

PEREKEME, Peresuode
Department of Mathematics, College of Education, Warri, Delta State, Nigeria
Email: princepppk1980@gmail.com.
Phone Number: +2348135071027

OKIGBO, Ebele Chinelo
Department of Science Education, Nnamdi Azikiwe University, Awka, Nigeria
Email: ec.okigbo@unizik,edu.ng
Phone Number: +2348037715662
DOI: 10.56201/ijasmt.v10.no5.2024.pg1.11

Abstract
The study investigated the effect of Kumon and framing teaching strategies on the retention of secondary school students in mathematics in the Delta-South Education Zone, Delta State, Nigeria. The study utilised a non-randomized pretest-posttest control group quasi-experimental design. The study population consisted of 19,201 SS2 students in the zone. The research employed a sample of 286 SS2 students, randomly selected from six intact classes. The instruments utilised were MAT and DARTM, both sanctioned by four experts. The MAT's reliability was assessed using the Kuder-Richardson Formula 20, yielding a coefficient of 0.86, whilst the DARTM's reliability was examined by the split-half approach, generating a reliability estimate of 0.81. The intervention involved teaching mathematics to the experimental groups using Kumon and structured teaching strategies, whereas the control group was instructed through an expository teaching strategy. A pretest was delivered before the treatment, followed by a post-test after the treatment, and a delayed post-test conducted three weeks later. The scores were aggregated and evaluated using mean, and ANCOVA at a 0.05 alpha level. The findings indicated a notable disparity in the average retention scores of students instructed in mathematics via the Kumon teaching strategy and the framing teaching strategy, compared to those taught through the expository teaching strategy, with a preference for the Kumon method, succeeded by the framing strategy. Moreover, there was no significant difference between the average retention scores of male and female students taught mathematics using the Kumon teaching, framing, and expository teaching strategy, among other findings. The research determined that Kumon and framing teaching strategies were helpful in improving mathematics retention among students in the Delta-South Education Zone. The findings recommend that secondary school mathematics teachers adopt and integrate the Kumon teaching strategy into their instruction, and utilise the framing teaching strategy as an alternative when the Kumon strategy is impractical.

Keywords: *Kumon and Framing teaching strategies, retention in mathematics, secondary school, Delta State*

Introduction

Mathematics is a methodical discipline that examines numbers, quantities, shapes, patterns, and their interrelationships. It includes multiple disciplines such as arithmetic, algebra, geometry, calculus, and statistics, and is defined by the application of abstract notions and logical reasoning to address issues and comprehend the world (Steen, 2013). Mathematics serves as an essential foundation for other disciplines, including science, technology, engineering, and mathematics (STEM). In Nigeria, where there is an increasing focus on technical progress and creativity, a robust comprehension of mathematics is crucial for students aspiring to pursue higher education in these fields (Ogunleye, 2015). The study of mathematics improves critical thinking and problem-solving abilities. It prompts students to evaluate circumstances, discern patterns, and formulate logical arguments. These talents are essential not only in academic environments but also in daily life and diverse vocations. Mathematics is essential for economic development and societal advancement. It is essential for making informed decisions in business, finance, and public policy. In Nigeria, where economic challenges persist, equipping students with mathematical skills can empower them to contribute effectively to the economy. Teaching mathematics at the secondary school level can help bridge the gap in educational inequalities.

Nonetheless, numerous research and publications have demonstrated inadequate performance in Mathematics among children in Nigeria. The West African Examinations Council (WAEC) results consistently show a high percentage of students failing Mathematics. For instance, in the 2021 WAEC results, only about 35% of candidates obtained credits in Mathematics (WAEC, 2021). The Trends in International Mathematics and Science Study (TIMSS) has indicated that Nigerian students perform below the international average in Mathematics. In the 2019 TIMSS, Nigeria ranked low compared to other participating countries, highlighting significant gaps in mathematical understanding (Mullis, Martin, Foy & Hooper, 2020). A study by Olatunde and Adebayo (2020) found that a significant number of secondary school students in Nigeria scored below average in Mathematics assessments, attributing this to various factors, including ineffective teaching strategy.

Expository teaching strategy is a direct instructional strategy that involves presenting information in a structured and systematic manner. This approach is often characterized by the teacher delivering content through lectures, demonstrations, or presentations, with the expectation that students will absorb and understand the material. While expository teaching can be effective in certain contexts, it also has several limitations that can hinder effective learning. The educator serves as the principal source of information, while students act as passive recipients of knowledge (Mayer, 2009). Information is conveyed in a coherent order, frequently including outlines, summaries, and visual aids. The objective is to guarantee that students comprehend and can retrieve factual information. A fundamental critique of expository teaching is that it frequently results in passive learning. Students may grow disinterested when they are not actively engaged in the learning process. Therefore, students' passivity during instruction may have contributed to students' poor performance in mathematics in external examinations such as WASSCE.

Therefore, there is need to try alternative teaching strategies such as Kumon and framing teaching strategies, which require students to engage with the material. It is believed that these active teaching strategies could be more effective in promoting understanding and retention in mathematics. Kumon is an educational method developed by Toru Kumon in the 1950s, primarily focusing on mathematics and reading. The Kumon method emphasizes self-paced learning, where students work through a series of worksheets designed to build their skills incrementally (Sunarsih, 2022). In this strategy, the students are encouraged to learn independently. They are provided with materials that are slightly above their current level, promoting a sense of achievement as they progress. The curriculum is designed so that each worksheet reinforces the preceding one, guaranteeing that students fully comprehend each idea prior to advancing to more intricate subjects. Addition, Kumon teaching strategy encourages frequent assessments help identify students' strengths and weaknesses, allowing for tailored instruction that meets individual needs. Parents play a crucial role in the Kumon strategy, as they are encouraged to support their children's learning at home. The goal is for students to achieve mastery in each topic before progressing, which helps build confidence and a solid foundation for future learning. Another teaching strategy that is related to Kumon teaching strategy is the framing teaching strategy.

Framing teaching strategies involve creating a structured environment that enhances learning by setting clear expectations, goals, and contexts for students (Brusilovsky & Millán, 2017). This strategy encompasses establishing specific learning goals that help students understand what is expected of them. During instruction using framing teaching strategy, the lessons are related to real-world situations that make learning more relevant and engaging for students. Group work and discussions that enhance understanding and retention of material are equally encouraged, and timely and constructive feedback are provided to help students recognize their progress. In developing this teaching strategy, the lesson is tailored to accommodate the varied needs of students, hence enhancing engagement and learning outcomes. The framing teaching strategy fosters active involvement in learning through the encouragement of participation and cooperation. It cultivates critical thinking and problem-solving abilities by prompting students to interact with the content substantively.

Kumon and framing teaching strategies offer effective alternatives for fostering independent learning, critical thinking, and mastery of content. By focusing on student engagement and personalized learning, these strategies could better enhance students' retention in mathematics than the expository teaching strategy. Retention refers to an individual's capacity to retain and retrieve information, resources, and experiences acquired over time. It may also be characterised as the capacity to retain concepts or information (Cowan, 2014). The objective is to maximise student engagement in science and mathematics, primarily relying on teachers to facilitate this learning. This study assessed retention with the Delayed Achievement Retention Test in Mathematics (DARTM). Three weeks subsequent to the posttest, the identical assessment will be administered to the same students to ascertain retention scores. Research evidence indicates that various elements, including instructional strategy, influence students' retention in mathematics. Consequently, it is essential to compare the efficacy of Kumon, framing, and expository teaching strategy on the retention of male and female students in mathematics. This is because, gender differences in achievement and retention have become serious issue in educational research.

Gender pertains to the anatomical and physiological attributes that differentiate males from females, while considering social and cultural diversities. Gender refers to the societal implications associated with an individual's biological categorization as either male or female. This encompasses the development of individual and collective identities, anticipated outcomes, actions and the distribution of authority that emerge from interpersonal exchanges (Ambe-Uva, Iwachukwu & Jubrin, 2008). The influence of gender and its interaction with instructional strategies have remained inconclusive. Studies had shown that certain instructional strategies favour males more than females and others reported otherwise. Some teaching strategies tend to be gender sensitive, while others are not (Izuegbunam, 2018). Effective teaching strategy, however, must have the potency to positively enhance achievement and retention of students, irrespective of students' gender. Thus, this study, further, ascertained if Kumon, framing and expository teaching strategies interact with students' gender to influence their retention in mathematics. This study aimed to investigate against this backdrop the effects of Kumon, framing and expository teaching strategies on students' retention in mathematics in Delta South Education Zone in order to identify and recommend the most effective teaching strategy for mathematics instruction between them. In addition, the study further sought to explore if Kumon, framing and expository teaching strategies can combine with students' gender to influence their retention in mathematics.

Statement of the Problem

The primary goal of teaching mathematics at the secondary school level is to impart fundamental understanding of mathematical ideas and principles to students by carefully selecting and organising content. In order to accomplish this goal, it is necessary to utilise suitable teaching strategies in the instruction and acquisition of mathematical knowledge, given the significant impact that mathematics has on the economic advancement of any nation. Mathematics, despite its importance, has exhibited a persistent deterioration in student performance in the Senior School Certificate Examination (SSCE), according to data from the West African Examination Council (WAEC) from 2016 to 2022. The subpar performance of students can be ascribed to multiple variables, including the employment of insufficient teaching strategies. The expository teaching strategy which is predominately used by mathematics teachers in Nigerian schools does not seem to promote active learning and carter for students' individual differences with respect to ability level, learning style and aptitude. This suggests that the expository teaching strategy does not promote active students' participation and take into consideration all the academic needs of individual students during instruction. Thus, there is the need to try other alternative teaching strategies such as Kumon and framing teaching strategies. These strategies make provision for individual students' academic needs during instruction. Therefore, the problem of the study is; will the use of Kumon and framing teaching strategies enhance mathematics students' retention than the expository teaching strategy?

Purpose of the Study

This study aimed to assess the effect of Kumon and Framing teaching strategies on students' retention of mathematics in the Delta South Education Zone. The investigation specifically identified the:

1. Average retention scores of students instructed in mathematics utilising the Kumon teaching technique (KTS), Framing teaching strategy (FTS), and Expository teaching strategy (ETS).

2. Average retention scores of male and female students instructed in mathematics utilising KTS, FTS, and those instructed utilising ETS.

Research Questions

Two research questions guided the study:

1. What are the mean retention scores of students taught mathematics using Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS) and Expository Teaching Strategy (ETS)?
2. What are the mean retention scores of male and female students taught mathematics using KTS, FTS and ETS?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean retention scores of students' taught mathematics using Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS) and Expository Teaching Strategy (TTS).
2. There is no significant difference in the mean retention scores of male and female students taught mathematics using KTS, FTS and ETS.

Methodology

This study utilised a non-randomized pretest-posttest control group quasi-experimental design. Intact courses were randomly assigned to the experimental and control groups. The independent variables comprise teaching methodologies, whereas the dependent variable is the retention score of mathematics students. The research population comprised 19,201 SS2 students from eight Local Government Areas in the Delta-South Education Zone, including 14,895 males and 4,306 females. The study sample consisted of 286 SS2 students, selected by a simple random sampling method from six co-educational secondary schools in the Delta-South Education Zone.

The research included two instruments for data collecting. The research tools employed consist of the Mathematics Achievement Test (MAT) and the Delayed Achievement Retention Test in Mathematics (DARTM). The face validity of MAT and DARTM was evaluated by four professionals in diverse fields of Science Education and Instrumentation. The researcher sent the initial drafts of the instruments, the study's objectives, scope, research questions, and hypotheses to the experts. They were asked to assess the items in the MAT and DARTM for lexical clarity, the plausibility of the distractors, and the appropriateness of the six-week instruction modules. The experts' feedback and recommendations were integrated into the final version of the instruments. The content validation of the MAT and DARTM was determined by a specification table. The internal consistency reliability of the MAT was pilot tested with 50 students from a school in the Burutu Local Government Area of Delta State, which possesses comparable characteristics to the sampled schools. The test's reliability coefficient was calculated via the Kuder-Richardson Formula 20. The utilisation of the Kuder-Richardson formula 20 yielded a reliability coefficient (r) of 0.86. The reliability of DARTM was assessed by the split-half method, yielding a reliability coefficient of 0.81.

The treatment involved educating students in the experimental group using Kumon and structured teaching strategies, whereas the control group was taught by expository teaching techniques. The MAT was conducted as a pre-test and post-test for both the experimental and control groups before and after the therapy. DARTM was executed three weeks after the posttest

administration. The pre-test, post-test, and delayed post-test data were examined utilising mean and ANCOVA.

Results

Table 1: Mean of Posttest and Delayed Test Scores of Students Taught Mathematics Using Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS) and Expository Teaching Strategy (ETS)

Group	n	Posttest		Delayed Posttest		Mean Loss
		Mean	SD	Mean	SD	
KTS	96	67.52	9.58	61.52	9.58	6.00
FTS	90	61.14	10.70	55.14	10.70	6.00
ETS	100	58.44	7.89	47.24	8.89	11.20

The results in Table 1 suggest that students in the KTS, FTS, and ETS groups experienced mean losses of 6.00, 6.00, and 11.20, respectively. This indicates that students in the KTS and FTS groups possess superior retention capabilities compared to their peers in the ETS group.

Table 2: Mean of Posttest and Delayed Test Scores of Male and Female Students Taught Mathematics Using Kumon Teaching Strategy (KTS), Framing Teaching Strategy (FTS) and Expository Teaching Strategy (ETS)

Group	Gender	n	Posttest		Delayed Posttest		Mean Loss
			Mean	SD	Mean	SD	
KTS	Male	46	67.39	9.50	61.39	9.50	6.00
	Female	50	67.64	9.75	61.64	9.75	6.00
FTS	Male	47	65.91	9.24	51.91	9.24	14.00
	Female	43	64.67	11.16	50.67	11.16	14.00
ETS	Male	42	59.05	8.86	48.00	10.00	11.05
	Female	58	58.00	7.16	46.69	8.05	11.31

Table 2 indicates that male and female students in KTS, FTS, and ETS incurred mean losses of 6.00 and 6.00; 14.00 and 14.00; and 11.05 and 11.31, respectively, in the mathematics concepts gained. This suggests that male and female students in each group shown almost equal recall abilities.

Table 3: ANCOVA on Difference between the Mean Retention Scores of Students taught Mathematics using KTS, FTS and ETS)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35844.682[a]	3	11948.227	3620.318	.000
Intercept	470.587	1	470.587	142.588	.000
Posttest	25804.629	1	25804.629	7818.815	.000
Strategy	1568.490	2	784.245	237.627	.000
Error	930.692	282	3.300		
Total	886921.000	286			
Corrected Total	36775.374	285			

Table 3 indicates that at a significance level of 0.05, with 2 degrees of freedom in the numerator and 282 degrees of freedom in the denominator, the computed F-value is 237.627, accompanied by a P-value of 0.000, which is less than 0.05. Consequently, the null hypothesis is dismissed. Consequently, there exists a substantial disparity in the average retention scores of students instructed in mathematics by KTS and FTS compared to those taught via ETS. A Scheffe Post-Hoc Analysis was performed to examine the direction of the differences, as detailed in Table 4.

Table 4: Scheffe Post-Hoc Analysis on Significance of Mean Difference in Retention between 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	-.093	.276	.737	-.637	.451
	ETS	5.068*	.280	.000	4.517	5.618
FTS	KTS	.093	.276	.737	-.451	.637
	ETS	5.161*	.266	.000	4.637	5.684
ETS	KTS	-5.068*	.280	.000	-5.618	-4.517
	FTS	-5.161*	.266	.000	-5.684	-4.637

Table 4 reveals no significant disparity in the average retention scores of students taught mathematics utilizing the KTS and FTS methods. Table 4.9 reveals a significant difference in the average retention scores of students taught mathematics via the KTS in contrast to the ETS, with KTS showing a preference. Table 4 reveals a significant difference in the average retention scores of students taught mathematics by FTS compared to ETS, with FTS being advantageous. This signifies that the trajectory of differences advances from KTS to FTS. This signifies that KTS enhanced student retention in mathematics, closely followed by FTS.

Table 5: ANCOVA on Gender Difference between the Mean Retention 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	1.482[a]	1	1.482	.016	.900
	Intercept	362650.148	1	362650.148	3910.882	.000
	Gender	1.482	1	1.482	.016	.900
	Error	8716.477	94	92.728		
	Total	372060.000	96			
	Corrected Total	8717.958	95			
FTS	Corrected Model	1026.021[a]	1	1026.021	9.856	.002
	Intercept	274631.354	1	274631.354	2638.063	.000
	Gender	1026.021	1	1026.021	2.856	.058

	Error	9161.101	88	104.103		
	Total	283869.000	90			
	Corrected Total	10187.122	89			
ETS	Corrected Model	41.826[a]	1	41.826	.526	.470
	Intercept	218414.946	1	218414.946	2748.270	.000
	Gender	41.826	1	41.826	.526	.470
	Error	7788.414	98	79.474		
	Total	230992.000	100			
	Corrected Total	7830.240	99			

Table 5 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 94 degrees of freedom in the denominator, the calculated F value is 0.016, with a P-value of 0.900, which surpasses 0.05. Thus, there is no significant difference in the average retention scores of male and female students taught mathematics using KTS. Table 5 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 88 degrees of freedom in the denominator, the calculated F-value is 2.856, with a corresponding P-value of 0.058, which surpasses 0.05. Thus, there is no significant difference in the average retention scores of male and female students taught mathematics using FTS. Table 5 demonstrates that at a significance level of 0.05, with 1 degree of freedom in the numerator and 18 degrees of freedom in the denominator, the calculated F value is 0.526, with a P-value of 0.470, which surpasses 0.05. As a result, there is no significant difference in the average retention scores of male and female students taught mathematics using ETS. Therefore, the null hypothesis is dismissed. Consequently, there is no significant disparity in the average retention scores of male and female students taught mathematics using KTS, FTS, and ETS. This signifies that KTS, FTS, and ETS uniformly enhanced the retention of male and female students in mathematics.

Discussion

The results indicated a substantial disparity between the average retention scores of students instructed in mathematics using KTS and ETS, favouring KTS. This finding is elucidated by the premise that KTS is founded on the principle of mastery, necessitating students to exhibit skill in a subject prior to advancing to the subsequent level. This method guarantees that students attain a comprehensive comprehension of each idea prior to advancement, perhaps resulting in superior recall rates compared to an expository teaching style that may transition to new topics before students have completely understood the existing material. This conclusion corroborates that of Ihendinihu (2018), which indicates a considerable disparity in the retention and attitudes of students between the experimental and control groups, favouring the experimental group. The study once more demonstrated a substantial disparity between the average retention scores of students instructed in mathematics via FTS and ETS, favouring FTS. This conclusion can be attributed to the KTS facilitating students' linkages among various mathematical concepts, hence enhancing their comprehension of the subject matter. Furthermore, KTS may have cultivated a more collaborative and participatory educational atmosphere, enabling students to learn from one

another and collaboratively address challenges. This finding aligns with Nneji's (2010) study that students' academic achievement significantly increased when exposed to KTS compared to ETS.

The study's findings indicated no significant difference in the average retention scores of male and female students instructed in mathematics using KTS. This indicates that male and female students instructed in mathematics using KTS achieved comparable retention levels. This finding may be attributed to equal participation. Male and female students engaged equally in the Kumon learning sessions, jointly contributing to and acquiring knowledge. This outcome corroborates Ashraf's (2018) claim that KTS is equally efficacious in instructing mathematics to both genders. The study emphasized that there is no substantial disparity in the average retention scores of male and female students instructed in mathematics using FTS. This is demonstrated by the equal engagement of both male and female students throughout training utilizing FTS. This finding corroborates that of Alhassan, Hassan, Gimba, and Mohammed (2022), which demonstrated no significant disparity in the mean retention scores of male and female students instructed in trigonometry using FTS. The study indicated no substantial disparity in the average retention scores between male and female students instructed in mathematics via ETS. This indicates that male and female students instructed in mathematics via the ETS achieved comparable outcomes on the retention evaluation. This may be ascribed to the tendency of both male and female students to passively assimilate knowledge from their educators during lectures. Furthermore, it is plausible that both male and female students in the study possess analogous learning preferences that enhance the ETS, resulting in comparable outcomes for both groups. This finding aligns with the research conducted by Chinemeze and Okigbo (2021), which indicated that gender does not significantly affect the mean retention and retention scores of students instructed in mathematics by the ETS.

Conclusion

The study established that KTS was significantly more effective in improving students' retention in mathematics than FTS. FTS also significantly improved retention in mathematics more than ETS. The study concluded therefore, that KTS is most effective teaching strategy for improving students' retention mathematics than FTS and ETS.

Recommendations

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

1. Mathematics educators in secondary schools should implement and include KTS into the instruction and learning of mathematics.
2. School administrators should conduct seminars and workshops on the adoption and utilisation of KTS in mathematics education.
3. Mathematics educators ought to employ FTS as an alternative pedagogical approach when KTS is impractical.

References

Alhassan, D. S., Hassan A. A., Gimba, R.W., & Mohammed, U. (2022). Effect of framing and team assisted individualized instructional strategies on trigonometric achievement of senior secondary school students in Niger State. *African Journal of Science, Technology and Mathematics Education (AJSTME)*. *8(2),* 105-110.

Ambe-Uva, T. N., Iwachukwu, O., & Jubrin, L. J. (2008). Gender analysis in National Open University (NOUN): Implication and policy issues in bridging the divide. *Journal of Applied Science Research*, *4(7),* 814-825.

Ashraf, J. (2018). Equal effectiveness of Kumon method of teaching mathematics among boys and girls. *Journal of English Language and Literature*, *9(3),* 906–913.

Brusilovsky, P., & Millán, E. (2007). User Modeling 2.0: The Future of User Modeling in Adaptive Hypermedia. User Modeling and User-Adapted Interaction, 17(5), 1-5.

Chinemeze, J. O., & Okigbo, C. E. (2021). Effects of planned and modified lesson study techniques on secondary school students' academic achievement and retention in mathematics. *South Eastern Journal of Research and Sustainable Development, 5(2),* 51-74.

Cowan, N. (2014). Working memory underpins cognitive development, learning, and education. *Educ Psychol Rev.*, 26(2), 197–223.

Ihendinihu, U. E. (2020). Comparative effects of mathematics laboratory resources on interest and achievement of students in mathematics. *Rivers State University Journal of Education (RSUJOE), 23(1&2),* 51-67.

Izuegbunam, A. G. (2018). Effect of cooperative and individualized instruction on students' achievement in chemistry in Awka south local government area (Unpublished Master's Thesis). Nnamdi Azikiwe University, Awka.

Mayer, R. E. (2009). *Learning and instruction* (2nd ed.). New York, NY: Pearson.

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2020). *TIMSS 2019* International Results in Mathematics and Science. Boston: Boston College.

Nneji, L. (2010). Impact of framing and team assisted individualized instructional strategies on students' achievement in Basic Science in the south zone of Nigeria. *International Journal of Education and Evaluation, 6(3),* 216-221.

Ogunleye, A. (2015). The importance of mathematics education in Nigeria. *International Journal of Education and Research, 3(5),* 123-134.

Steen, L. A. (2013). Mathematics and democracy: The case for quantitative literacy. New York, NY: National Council on Education and the Disciplines.

Sunarsih, S (2022). The effectiveness of the Kumon method with tapertis media towards understanding the multiplication concept of elementary school students. *Journal of Progres Pendidikan, 3(3),* 170 – 175.

WAEC (2016-2022). *West African Examinations Council Annual Reports*. Lagos: WAEC Press.