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Effect of Teach-Pause-Check Instructional Strategy on Students' Achievement and Knowledge Retention in Mathematics

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Abstract

*The study examined the effect of Teach-Pause-Check (TEPAC) instructional strategy on students' achievement and knowledge retention in mathematics. The study was a quasi-experimental type adopting the pretest, posttest non-randomized control design. A sample of one hundred and sixty (160) senior secondary two (SS2) students was drawn from 2 purposively selected coeducational Government owned secondary schools in Owerri municipal Council of Imo State. The experiment group was taught using TEPAC instructional strategy while the control group was taught using the conventional approach. Data required for the study were collected using a researcher constructed objective test titled "Mathematics Achievement Test (MAT)". The construction of the test was guided by a table of specification. The instrument had reliability coefficient of 0.82 obtained through Kuder Richardson 20(KR20) formula. The data generated were analyzed using Analysis of Covariance (ANCOVA) tested at 0.05 level of significance. The result of the study revealed that the TEPAC group outperformed the control group culminating in a significant difference between the mean achievement scores of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach (*F (1, 155) = 195.980, P = 0.000 < 0.05*). There was no significant interaction effect between gender and Teach-Pause-Check (TEPAC) instructional strategy on Student's Achievement in Mathematics (*F (1, 155) = .678, P = 0.412 > 0.05*). Finally, there was a significant difference between mathematics knowledge retention of students taught using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach implying that the TEPAC group had better retention ability than those in the control group (*F (1, 155) = 286.944, P = 0.000 < 0.05*). Based on the results, it was recommended among others that, Mathematics teachers should be encouraged to use TEPAC in teaching to improve students' achievement.*

Keyword**:** *Teach-Pause-Check, Instructional Strategy, Achievement, Knowledge Retention.*

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Introduction

The inestimable value of mathematics in the development of a society cannot be overemphasized. The power of Mathematics for describing and analyzing the world around us is such that it has become a highly effective tool for solving problems. It is the gateway and key to science. All scientific education which does not commerce to the mathematics is said to be defective at its foundation. Mathematics is one of the greatest cultural and intellectual achievements of humankind and citizens should develop an appreciation and understanding of the achievement. In the changing world today, those who understand and can-do mathematics will have opportunities and options for shaping their futures brighter. All students should have the opportunity to learn significant Mathematics with depth and understanding such that they exhibit different talents, abilities, achievements, needs and interests in Mathematics. However, the teaching and learning of mathematics at secondary school level has become very problematic to both students and teachers.

The students' understanding and problem-solving skills in this all-important subject is dependent on the teachers' instructional techniques. Johnson et al. (2019) realizing the importance of mathematics as a foundational subject and problem-solving as a critical skill, opined that effective teaching approaches to improve mathematical learning outcomes in this environment are essential. Abiodun (2024) noting how teaching strategies might help students learn more, reported that teachers' use of inefficient teaching strategies to impart knowledge to students is substantially linked to most students' routinely poor academic performance. Similarly, Weinfield (2017) inferred through extensive research on the effectiveness of teaching strategies that the quality of instruction is frequently reflected in students' academic success. Adamu (2020) indicated that Mathematics enjoys a special status in the school curriculum by being one of the core subjects and that more mathematics lessons are taught in schools than science. It was further reported that, irrespective of the fact that mathematics is essential for daily life and plays a crucial role in school curriculum, students' performance remains very low, and this could be attributed to the teaching methods adopted by the teachers.

Most mathematics teachers are noted to dwell on the traditional approach of teaching which is teacher-centered and does not give the students the opportunity to engage in active participation in the learning process. In this approach, the teacher is typically the central figure in the classroom, and they primarily use lectures, demonstrations, and repetitive practice to help students grasp mathematical concepts. The approach is characterized by focusing on memorization, practice and drill; limited student interaction and assessment is focused on right answer. In the words of Echazarra et al. (2016) traditional approach, characterized by teacher-directed instruction and memorization, is less effective for complex mathematics problems. Students need strategic and creative thinking, indicating that reliance solely on memory does not lead to optimal performance in mathematics assessments. Similarly, Lee and Paul (2023) indicated that the traditional, lecture-based approach in mathematics often leads to standardized, passive learning, resulting in student disengagement and poor understanding. This method fails to cater to diverse learning styles, negatively impacting overall student performance and critical thinking skills. To meet the criteria of curricula, the approach focuses on providing information and knowledge, and teaching materials are frequently curriculum-directed. The need for effective students' performance requires that student-centered learning approaches should be adopted in a mathematics classroom. These approaches allow the students to take the center stage of the learning process through active engagement. Emaliana (2017) stated that student-centered approach is based upon the concept of constructivism that learners confer meanings to what they learn by

relating new information to what they have already known. More interactive and practical exercises are frequently a part of student-centered learning. Students are more likely to get a deeper comprehension of mathematical ideas when they are actively involved in the learning process. Since active participation helps students retain information better, this can result in better performance. This method fosters the growth of critical thinking and problem-solving abilities by encouraging students to investigate mathematical problems individually or in groups. Students frequently improve their mathematics skills and gain confidence in their abilities by overcoming obstacles and solving problems on their own. In mathematics, where students may have different levels of understanding, the student-centered model helps ensure that all students are supported and challenged appropriately. Instructional strategies that actively involve learners and provide opportunities for processing and checking understanding during lessons have been recommended to address these challenges. One instructional strategy that can grantee student-centered learning is Teach-Pause-Check (TEPAC) instructional strategy.

Teach-Pause-Check (TEPAC) instructional strategy is a collaborative and student-centered teaching approach that allows the teacher to teach, pause for some minutes to check through students understanding of concept and also allow students to ask questions, make useful contributions, interact with peers and continue with the teaching and learning process after the specified time usually 3-5 minutes. This approach is also referred to as pause process or approach of teaching by some researchers. In a mathematics classroom context, the teacher plans a lesson considering the pause time. The teacher introduces the mathematics concept and takes it on and pause after 10-15 minutes. Within this period, there will be teacher-student interaction where teachers entertain questions from students, observe what the students are doing and ask students questions on the concept under discussion to make clarifications. Also, there is student-student interaction involving peer discussions, communication of ideas. Damian cited in Akinwamide and Olofin (2022) described Pause procedure as a technique in which the teacher uses strategic pauses to provide students with the time during which they can review their notes, discuss among their peers or undertake any similar activities that allows them to clarify, assimilate and retain the material. Bachhel and Thaman (2014) opined that ‘pause procedure’ is one active learning strategy which requires very little class time and can significantly enhance student learning. Hartley and Davies cited in Bachhel and Thaman (2014) reported that pausing may also be helpful because the students mind begin to wander and this break provides them the opportunity to start fresh again, keeping students engaged. In the words of Cohrssen et al. (2014) the pause teaching process in mathematics involves intentionally incorporating pauses during interactions, allowing children time to think, initiate topics, and engage more equitably in discourse, while enabling teachers to assess understanding and provide individualized scaffolding effectively. Chaudhry et al (2024) stated that the pause teaching process involves strategically incorporating pauses during lectures to enhance student understanding and retention. This method allows students to reflect, clarify doubts, and maintain attention, ultimately improving learning outcomes and academic performance in educational settings. Akinwamide and Olofin (2022) reported that the use of pause teaching process enhanced Mathematics performance by allowing time for reflection and interaction, ultimately leading to improved learning outcomes for students. Bachhel and Thaman (2014) inferred that when a set of students in neuromuscular physiology class was taught using pause strategy, the result showed that this strategy had positive effect on the performance of the students when compared with another set of students that were taught conventionally. The pause procedure also helps students to review, compare notes and briefly reflect on the lecture. Thus, it also promotes self-monitoring. Ingram and Elliott (2016) reported that pausing for more than three

seconds is associated with an increase in the likelihood of response and ultimately greater learning gains. Lubis and Surya (2016) reported that the stop think do approach significantly improved mathematics learning outcomes, with an effective percentage of 75% and better results in the experimental class compared to the control class.

Retention of knowledge in mathematics refers to the ability of students to retain and apply mathematical concepts and skills over time. This concept is crucial for ensuring that students can effectively utilize their mathematical knowledge in future academic and professional contexts. It involves the long-term storage and retrieval of mathematical information in the brain, so individuals can continue to use the knowledge they've learned, even after a period has passed. Several key factors contribute to how well students retain mathematical concepts, and different teaching strategies can have varying levels of effectiveness. For instance, Awodeyi and Udo (2017) found that the method combination therapy significantly enhanced students' retention of knowledge in mathematics, particularly in geometry, compared to traditional methods. This suggests that varied instructional strategies positively impact students' ability to recall acquired knowledge over time. The Teach-Pause-Check strategy enhances students' retention of mathematics knowledge in several ways. First, pause reduces cognitive overload by allowing students time to process information before new content is introduced, second, checking for understanding provides immediate feedback, enabling students to correct misconceptions early. Third, peer discussion during pauses encourages verbalization of mathematical reasoning, which has been shown to improve memory retention.

Gender achievement in mathematics has been an issue within secondary school levels. This has affected the involvement and equity of male and female students in science, engineering and technology-oriented courses in higher education. However, there has been no agreement on the direction of mathematics performance among male and female students. For instance, Oliweh and Oyem (2021) reported that there is no significant difference in the performance of male and female students in mathematics. Ajai and Imoko (2015) assessed gender differences in Mathematics achievement and retention by using Problem-Based Learning (PBL). The study revealed that male and female students taught algebra using PBL did not significantly differ in achievement and retention scores, thereby revealing that male and female students can compete and collaborate in Mathematics. However, Alordiah et al. (2015) investigated the influence of gender on students' academic achievement in Mathematics, and it was found that students have an average achievement in Mathematics; the result also showed that male students performed better than female students. Oribhabor (2019) in a study reported that there is a significant difference in the mathematics achievement of the male and female students in favour of the males. This calls for further research to determine the direction of mathematics performance with respect to gender.

Considering the abysmal performance of students in mathematics at secondary school level due to teachers' instructional strategies, and the quest for improved student outcomes in the subject, it becomes pertinent to try out the Teach-Pause-Check (TEPAC) instructional strategy irrespective of the scanty literature on it within the area of the study. The study was therefore, carried out to investigate the effect of Teach-Pause-Check (TEPAC) instructional strategy on student's achievement in mathematics in secondary schools in Owerri municipal council of Imo state, Nigeria.

Purpose of the Study

The study was carried out to investigate the effect of Teach-Pause-Check (TEPAC) instructional strategy on student's achievement and knowledge retention in mathematics in secondary schools. Specifically, the study determined.

1) The difference between the mean achievement scores of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.
2) The interaction effect between gender and Teach-Pause-Check (TEPAC) instructional strategy on student's achievement in mathematics.
3) The difference between mathematics knowledge retention of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Hypotheses

The following hypotheses guided the study

Ho_1: There is no significant difference between the mean achievement scores of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Ho_2: There is no interaction effect between gender and Teach-Pause-Check (TEPAC) instructional strategy on student's achievement in mathematics.

Ho_3: There is no significant difference between the mathematics knowledge retention of students taught using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Methods

The study was a quasi-experimental research type adopting the pre-test, posttest non-randomized control design to investigate the effect of TEPAC instructional strategy on student's achievement and knowledge retention in mathematics in secondary schools. The population of the study consists of all the 4,044 senior secondary two (SS2) students of the 10 Government owned secondary schools in Owerri Municipal council of Imo State. Two coeducational secondary schools were purposively selected for the study based on their nature. In each of the schools selected, two intact classes were randomly selected and assigned to control and experiment groups. These gave a sample size of one hundred and sixty (160) students consisting of 82 males and 78 females. The experiment group consist of seventy-four (74) students (34 males and 40females) while the control group consist of eighty-six (86) students (37 males and 49females). The instrument for data collection was a researcher made 30-items objective test questions titled "Mathematics Achievement Test (MAT)". A table of specification was used to draw up questions based on the topics taught by the students. The response options ranged from A-D with one correct answer and three distracters. The instrument was validated by 2 experts in mathematics education and 1 expert in measurement and evaluation. Their expert judgments guided the restructuring of the instrument to meet the objectives of the study. To determine the reliability of the instrument, 25 copies were pilot tested on students with the same characteristics as the study group but outside the selected schools. The result gave a reliability coefficient of 0.83 using Kudder-Richardson formula 20 (KR20). Two research assistants were trained for two weeks on the application of TEPAC instructional strategy in mathematics teaching and learning. To ensure groups were comparable prior to treatment, both groups were pre-tested before the

instructional treatment. The experiment group was taught algebra (quadratic equation) by the research assistant using a detailed TEPAC lesson plan. The lesson plan guided the research assistant through a detailed process of Teach-Pause-Check instructional strategy. The control group was taught the same concept by their regular classroom teacher using a provided conventional approach lesson plan. The entire learning process was restricted around the teacher, and the students were passive during the entire process. The process lasted for four weeks after which the posttest was administered to both groups using a rearranged pre-test instrument and scored over 100percent. To measure retention, a delayed post-test was administered to both groups after two weeks. The data generated were analyzed using Analysis of Covariance (ANCOVA) to test the hypotheses at 0.05 level of significance.

Result

Ho_1: There is no significant difference between the mean achievement scores of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Table 1: Summary of ANCOVA analysis on achievements

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	18301.082[a]	4	4575.271	51.031	.000
Intercept	10434.147	1	10434.147	116.378	.000
Pretest	244.422	1	244.422	2.726	.101
Gender	**80.930**	**1**	**80.930**	**.903**	**.344**
Method	**17571.087**	**1**	**17571.087**	**195.980**	**.000**
Gender * Method	60.787	1	60.787	.678	.412
Error	13896.912	155	89.657		
Total	332267.000	160			
Corrected Total	32197.994	159			

Table 1 shows that F(1, 155) = 195.980, P = 0.000 < 0.05. Thus, the null hypothesis is rejected and the alternative accepted. This implies thatthere is a significant difference between the mean achievement scores of students taught mathematics using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approaches.

Ho_2: There is no significant interaction effect between gender and Teach-Pause-Check (TEPAC) instructional strategy on Student's Achievement in Mathematics.

Table 1 shows that F(1, 155) = .678, P = 0.412 > 0.05. Thus, the null hypothesis is upheld and the alternative rejected. This implies that there is no significant interaction effect between gender and Teach-Pause-Check (TEPAC) instructional strategy on student's achievement in mathematics.

Ho_3: There is no significant difference between mathematics knowledge retention of students taught using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Table 2: summary of ANCOVA analysis on retention of knowledge

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	24745.064[a]	4	6186.266	74.165	.000
Intercept	10668.523	1	10668.523	127.901	.000
Pretest	370.075	1	370.075	4.437	.037
Gender	264.754	1	264.754	3.174	.077
Method	**23934.653**	**1**	**23934.653**	**286.944**	**.000**
Gender * method	.552	1	.552	.007	.935
Error	12928.911	155	83.412		
Total	360056.000	160			
Corrected Total	37673.975	159			

Table 2 shows that F (1, 155) = 286.944, P = 0.000 < 0.05. Thus, the null hypothesis is rejected and the alternative accepted. This implies that there is a significant difference between mathematics knowledge retention of students taught using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach.

Discussion

The study investigated the effect of Teach-Pause-Check instructional strategy on student's achievement and knowledge retention in mathematics in secondary schools. The result of the study revealed that students taught mathematics using TEPAC instructional strategy had better and higher achievement scores than those taught using conventional approach. This result gives clear evidence that when students are taught mathematics using student-centered approach that grants them the opportunity to communicate with both teachers and peers, and participate actively in the learning process, they tend to perform better. This result is in tandem with the report of Akinwamide and Olofin (2022) which revealed through the posttest data analyses of their study that there is a significant difference in the performance scores of the students in pause approach and traditional groups.

The result of the study revealed that students' achievement in mathematics is dependent on the instructional approach employed by the teacher and not gender. It was evident in the result as there was no significant interaction effect between gender and Teach-Pause-Check instructional strategy resulting to equity in gender achievement in mathematics. This result is suspected to have occurred due to the interaction, sharing of ideas non-gender stereotype and collective problem-solving opportunity involved in the strategy. The result is in consonance with Akinwamide and Olofin (2022) which found no significant difference in the performance of male and female students under the use of pause procedure. The result also aligns with Mbacho (2022) who reported that gender did not affect students' achievement in mathematics when taught using the Jigsaw Cooperative Learning Strategy, indicating that this instructional method can help reduce gender disparities in mathematics achievement among secondary school students.

Finally, the study revealed that TEPAC enhanced students' retention of mathematical knowledge. The findings showed that there is a significant difference between mathematics knowledge retention of students taught using Teach-Pause-Check (TEPAC) instructional strategy and those taught using conventional approach. The result is similar to Iyekekpolor et al. (2024) which revealed that there is a significant difference in mean knowledge retention of students taught geometry using the conceptual instructional strategy and conventional teaching strategy.

Conclusion

The result of the study revealed that Teach-Pause-Check (TEPAC) instructional strategy enhanced students' achievement in mathematics, knowledge retention and diminished gender disparity. It revealed that mathematics achievement, and knowledge retention of students is dependent on the strategy applied in teaching. Students' achievement in mathematics does not depend on gender rather it depends on strategy adopted by the teacher. Adopting low-tech, interactive strategies like TEPAC can be a practical step toward improving mathematics learning in a resource-limited setting.

Recommendation

Based on the findings of the study, the following recommendations are made.

1). Mathematics teachers should be encouraged to use TEPAC instructional strategy in teaching to improve students' achievement.

2). Government, NGOs and school managers should organize workshops, seminars and conferences regularly to train teachers on innovative strategies of teaching mathematics such as TEPAC.

3). Student-centered instructional strategies such as TEPAC should be incorporated in pre-service teachers' curriculum by curriculum planners.

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