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EFFECT OF THINK-PAIR-SHARE INSTRUCTIONAL STRATEGY ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN ONITSHA EDUCATION ZONE, ANAMBRA STATE.

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ABSTRACT

Considering student' under achievement in mathematics especially in circle geometry, the study investigated the effect of Think-Pair-Share instructional strategy on senior secondary school students' achievement in mathematics. Quasi Experimental, specifically, pre-test posttest non-randomized control group research design was adopted for the study. Two research questions and three hypotheses, tested at 0.05 level of significance, guided the study. A multi-stage sampling procedure was used to sample eighty (80) SS II mathematics students. Data was collected using a researcher - constructed Mathematics Achievement Test (MAT). The instrument was validated by three experts. The reliability of the instrument was established using Kuder-Richardson formula 20 (KR-20) which yielded a reliability coefficient of 0.85. Data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA). The findings of the study revealed that students taught mathematics using Think-Pair-Share (TPS) instructional strategy out-performed their counterpart taught same concepts using direct instruction. Furthermore, it was observed that female student taught mathematics using TPS slightly outperformed their male counterparts. Again, there was no statistically significant interaction effect of gender and teaching methods on students' achievement in mathematics. Based on the findings, it was recommended, among others, that Mathematics educators should incorporate TPS instructional strategy as an innovative strategy while teaching mathematics in secondary schools and that workshops and seminars should be organized for mathematics teachers to get them acquainted with the use of TPS instructional strategy.

Keywords: Think-Pair-Share, Academic Achievement, Circle Geometry, Mathematics, Quasi-Experimental

Introduction

Science is a systematic study that builds and organizes knowledge through observation, experimentation and analysis. It seeks to explain natural phenomena, uncover fundamental laws, and applying discoveries to solve real-world problems. Science enhances our understanding of the universe and drives technological advancements. One of its essential tools for precision and logical reasoning is Mathematics, which provides the quantitative foundation for scientific inquiry and problem-solving.

Mathematics according to Ahmad (2016) is primarily concerned with ideas, processes and reasoning that brings about

solutions to human problems. It consists of thinking in a logical manner, formulating and testing conjectures, making senses of things, forming and justifying judgments, inferences and conclusion. The application of mathematics cuts across all areas of science, technology, commerce, agriculture, health and many more. Mathematics is the ingredient that spices up all other disciplines. In Nigeria, Mathematics is one of the core subjects a student must pass at credit level before proceeding to higher institutions of learning because of its importance. According to Hasanah and Surya (2017), some of the purposes of learning mathematics in school is to train students in thinking and reasoning and in reaching conclusions, in developing the ability to solve problems, providing information or communicate ideas through speech, writing, pictures, graphs, maps, diagrams, and so on. Hasanah and Surya (2017) opined that knowledge of mathematics, especially in geometry, should be provided to all learners, beginning from elementary schools to equip them with the ability to think logically, analytically, systematically, critically, creatively, and cooperatively.

Geometry is the study of the properties of shape. It is a core aspect of the Mathematics curriculum that is essential to the development of spatial awareness and geometric reasoning skills among students. Mathematical reasoning and reasoning skills are developed and strengthened by studying geometry, which is like a tool for thinking logically. Geometric and productive thinking rely on the capacity to reason about connections inside and between geometric forms. As a result, students are required to engage in reasoning tasks and acquiring particular geometric thinking abilities that will aid in their future study of geometry. Its branches include Euclidean, Non-Euclidean, Analytic, Projective, Differential Geometry and Topology. Euclidean geometry is mostly taught in schools. It deals with properties of flat, two-dimensional shapes and the relationship between points, lines and angles in a plane. Hence circle geometry fall under Euclidean geometry.

In geometry, a circle is a two-dimensional (2D) shape consisting of all the points that are at a given distance from a fixed point called the center of the circle (Haylock, 2018). (Arnigo et al., 2018) and Mollakuqe et al. (2021) described it as a flat figure of special importance shown in the variety of its application in our daily lives. Learning of circles starts from its basic units, which are the radius, diameter, areas and properties, up to its applications. This implies that students should have more experience and knowledge in lower-level skills, in this case definitions and relationships, before they can progress to reasoning at a high level of difficulty such as its application (Arnigo et al., 2018). Circle Geometry has posed serious problems to students because of the theorems involved in the topic and because most teachers often adopt teacher-centered-method in teaching the topic. The West Africa Examination Council (WAEC) Chief Examiners' Reports from 2015 to 2018 has identified circle geometry as a difficult area in Mathematics for students. Durojaiye (2016) also identified it as one of the topics in Mathematics that students found difficult to complete properly when they are part of questions that had to be answered compulsorily, hence most students

avoid them when they were optional. According to the 2016 WAEC Chief Examiners' report, students' poor performance in circle geometry may be linked back to issues relating to the teaching approaches and methods adopted by the teacher. There have been several studies (Ajani and Olabode, 2018; Durojaiye, 2016; Timayi, Bolaji and Kajuru, 2015; Unodiaku, 2018) pointing to the difficulties that students experience while studying circle geometry. Knowledge of circle geometry is an imperative for deductive reasoning and visual recognition of geometrical properties (theorems). Even though circle theorems are basic and beautiful notions in geometry, students have found the different theorems they must memorize to be a serious struggle (Hissan and Ntow, 2021). This is because students see circle geometry as abstract and technical, making it one of the most difficult concepts to grasp. Hissan and Ntow (2021) noted that it is common for teachers not to correctly present the notion of circle theorems to students for them to comprehend before advancing fast toward its features and solving related problems because teachers often adopt a teacher-centered method of teaching (Direct instruction or traditional method) in teaching mathematics.

Direct instruction is the lecture method of teaching whereby the teacher remains active while the learners are passive throughout the lesson. Direct Instruction, though appropriate while addressing large crowds of students and thus enhancing timely coverage of syllabus could make the lesson uninteresting and difficult for the students to learn. This method of teaching has been described by Falebita (2019) as being ineffective. There is therefore a need for the adoption and usage of student-centered methods or strategies that will make the teaching and learning of circle geometry fascinating and productive. Think-Pair-Share instructional strategy which is a co-operative learning style has been recognized as an important instructional strategy that enhances Mathematics learning and promotes social interaction among students.

Think-pair-share (TPS) is a cooperative discussion strategy developed by Frank Lyman and his colleagues in Maryland. It gets its name from the three stages of student action, with emphasis on what students are to be doing at each of those stages. Engaging in Think-pair-share, students work together to solve a problem or answer a question about an assigned reading or task. This strategy requires students to think individually about a topic or answer to a question and share ideas with classmates. Discussing with a partner maximizes participation, focuses attention and engages students in comprehending the problem.

TPS is a model of cooperative learning in pairs that give students more time to think, respond, and to help each other. Farrajallah (2017) reported that using think-pair-share instructional strategy turns the classroom into a scientific, cultural and entertainment field endeared to the students' soul by which the information is passed to the students in an interesting and attractive image. Think-Pair-Share instructional strategy can improve students' ability to recall information and a student can also learn from other students and convey to each other ideas for discussion before being submitted to the class. Think-Pair-Share

means giving time for students to think about answers to questions and helping each other to resolve the issue with the capabilities of each. Sejani (2016) posited that TPS enhance the problem solving and mathematics learning outcomes of students, creating an active learning environment and providing benefits to learning in the classroom. According to Napitupulu and Surya (2017), TPS is a cooperative learning model that is considered to arouse students' interest in mathematics and make students more active, socialize and encourage cooperation among students in learning the material, thus enhancing students' achievement in Mathematics.

Academic achievement as defined by Daniels and Schouten in Mekonnen (2014) is the scholastic standing of a student at a given moment as explained in terms of the grades and performance on an educational achievement test and cumulative indicators such as educational degrees and certificates. Steinmayr, MeiBner, Weidinger and Werthwein (2015) further define academic achievement as performance outcomes that indicates the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments; specifically, in schools, colleges and universities. It is a measure of output and the main outputs in education are expressed in terms of learning, that is, changes in knowledge, skills and attitudes of individuals as a result of their experiences within the schools' system. Academic achievement is influenced by various factors, including cognitive abilities, learning strategies, and environmental conditions. Among these, gender has been widely studied as a potential moderating variable shaping academic achievement through differences in motivation, self-efficacy, and social expectations.

Gender refers to the social or cultural constructs, characteristics behaviors and role which society ascribes to males and females. Kolawole (2019) define gender as a socio-culturally constructed idea that ascribes qualities and roles to sex, such as men and women within society. Gender is not determined biologically due to the sexual characteristics of either women or men but is constructed socially. Gender is a person's self-representation as male or female or how that person is responded to by social institutions based on the individual gender presentation. Yang and Chen (2013) state that among various human factors, spatial ability and gender differences are critical to geometric learning and gender differences play an important role in geometric learning because boys and girls show different outcomes in different learning environments when they learn geometry. It can be noted that the balance between spatial and logical ability can play a role in geometry performance in general (Battista, 2013). Bal (2017) argued that attitude is an important predictor in the context of success in geometry, and gender is an important factor affecting success because cultural factors are dominant over biological factors. Gender differences in mathematics achievement and ability have remained a source of concern as scientists seek to address the under-representation of women at the highest levels of mathematics, physical sciences and engineering (Asante, 2020). Therefore, understanding whether gender influences

students' academic achievement in circle geometry when taught using the Think-Pair-Share instructional strategy becomes crucial, especially considering reports that students struggle with geometry due to its challenging nature, as highlighted by the National Business and Technical Examinations Board (NABTEB) Chief Examiners Mathematics Report (2012).

This was reaffirmed by WAEC Chief examiners report (2019 to 2023) which also reported that students show weakness in the topic. However, students' poor achievement in mathematics has been attributed to inefficient and ineffective method of teaching. One good way of effecting a change in method of teaching a subject is to discover through experimentation and empirical evidence that such method can yield effective instructional outcomes. In order to enhance students' achievement in circle geometry concepts, it is important to consider teaching such topics using learner-friendly methods such as the Think-Pair-Share instructional strategy. This is the premise on which this study was conceived. It is the goal of the study to examine the effect of TPS instructional strategy on students' academic achievement in circle geometry in General Mathematics in Senior Secondary Schools in Onitsha Education Zone. Specifically, the study sought to determine

1. the difference in the achievement scores of SS 2 students' taught circle geometry using Think-Pair-Share Instructional Strategy and that of those taught using Direct Instruction Method.
2. the difference in the achievement scores of male and female SS 2 students taught circle geometry using Think-Pair-Share Instructional Strategy.
3. Interaction effect of instructional strategies and gender on SS 2 students' achievement in circle geometry.

Research Questions

The following research questions were posed to guide the study:

1. What is the difference in the mean achievement scores of SS 2 students taught circle geometry using Think-Pair-Share instructional strategy and those taught using direct instruction method?
2. What is the difference in the mean achievement scores of male and female SS 2 students taught circle geometry using Think-Pair-Share instructional strategy?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference between the achievement scores of SS 2 students taught circle geometry using Think-Pair-Share instructional strategy and those taught using direct instruction method.
2. There is no significant difference between the achievement scores of male and female SS 2 students taught circle geometry using Think-Pair-Share instructional strategy.
3. There is no significant interaction effect of instructional strategies and gender on the achievement scores of SS 2 students in circle geometry.

Methods

The study adopted quasi-experimental, specifically, the pretest, posttest nonrandomized control group design. The population of the study comprised of 5056 SS 2 students from the 32 public secondary schools in Onitsha Education Zone of Anambra State. The sample of the study was comprised of 80 (41 males and 39 females) SS 2 students drawn from two out of 20 co-educational secondary schools in Onitsha Education Zone of Anambra State. The sampling was drawn using two-stage sampling approach involving simple random and purposive sampling methods. The instrument that was used for data collection was Mathematics Achievement Test (MAT). The MAT was adapted from WASSCE past questions. The MAT is designed into two sections, A and B. Section A sought personal information on the students while Section B contains 25 multiple - choice questions on circle geometry. Each question has four options a, b, c and d and students are required to pick the correct option.

The instrument was validated by three experts; two from the Department of Science Education and one from Department of Educational Foundations with a bias in measurement and evaluation; all from Faculty of Education Nnamdi Azikiwe University, Awka. To determine the reliability of the MAT, the instrument was administered to an intact class of 20 SS 2 students in one of the schools outside the zone under study. Kuder- Richardson formula 20 (KR-20) was used to analyze the data collected. The choice of KR-20 was because the instrument was dichotomously scored. The reliability coefficient for MAT was found to be 0.85.

The experiment was carried out in two phases, in the first phase, the teacher in the experimental group was briefed by the researcher before the treatment process on how to effectively use Think-Pair-Instructional Strategy, while the teacher in the control group was given topics with the lesson plans and then asked to teach the students as usual. Before the commencement of the experiment, both the experimental and control groups took a pretest as part of the pre-testing and familiarization phase. At the end of the test the question papers and answers were collected from the students by their teachers. The pretest papers were marked and scored by the researcher. In the second phase, teaching commenced on the next mathematics class by their regular teachers for four weeks on circle geometry. After the teaching, posttest was administered to the subjects by their regular mathematics teachers. The test was again marked and scored by the researcher. The aim of the posttest was to find out if there was any gain in knowledge that might have arisen as a result of the treatment.

The data obtained from each group on the Mathematics Achievement Test (MAT) was analyzed using mean and standard deviation to answer the research questions and ANCOVA to test the hypotheses at 0.05 level of significance. The choice of ANCOVA for testing the hypotheses was based on its ability to control the initial group difference. The decision rule for the hypotheses was that whenever the probability value (p-value) is less than or equal to the significant value of 0.05, the null hypothesis

is rejected, otherwise the null hypothesis is not rejected.

Results

Table 1: **Mean and standard deviation on achievement scores of students taught circle geometry using TPS and those taught using DIM**

		Pre-test		Post-test		
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
TPS	41	10.4	4.733	15.2	3.855	4.8
DIM	39	10.8	3.759	14.7	4.005	3.9
Mean Diff.		-0.4		0.5		0.9

Table 1 revealed that students taught circle geometry using the Think-Pair-Share (TPS) method had a pre-test mean score of 10.4 and a post-test mean score of 15.2, with a mean gain of 4.8. On the other hand, students taught using the Direct Instruction Method (DIM) had a pre-test mean score of 10.8 and a post-test mean score of 14.7, with a mean gain of 3.9. Therefore, this suggests that both TPS and DIM were effective in enhancing students' academic achievement. However, compared to the DIM, the TPS method was more effective than the traditional DI method of teaching, as indicated by a mean gain difference of 0.9. This implies that TPS was effective in improving students' achievement than DIM.

Table 2: **Mean and standard deviation on achievement scores of male and female students taught circle geometry using TPS**

			Pre-test		Post-test		
Method	**Gender**	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean gain**
TPS	Male	24	9.37	3.86	14.10	3.60	4.73
	Female	17	10.61	4.31	16.76	3.75	6.15
Mean Diff.			-1.24		-2.66		-1.42

Table 2 revealed the mean achievement and standard deviation scores of male and female students taught circle geometry using TPS. It was observed that male students taught with the TPS method had a pre-test mean score of 9.37 and a post-test mean score of 14.10, with a mean gain of 4.73. Female students taught with the TPS method had a pre-test mean score of 10.61 and a post-test mean score of 16.76, resulting in a higher mean gain of 6.15. This indicates that the TPS method was more effective for female students, as reflected in the mean gain difference of -1.42.

***Table 3*: Summary of Analysis of Covariance of interaction effect of instructional strategies (TPS and DIM) and gender on the achievement scores of students in circle geometry**

Sources of Variation	Sum of Squares	df	Mean Square	F	*P*-value	Decision
Corrected Model	910.681[a]	4	227.670	57.441	.000	
Intercept	380.239	1	380.239	95.933	.000	
Pre-test	825.367	1	825.367	208.238	.000	
Method	8.445	1	8.445	2.131	.000	Sig.
Gender	.831	1	.831	.210	.648	Not Sig.
Method * Gender	3.873	1	3.873	.977	.326	Not Sig.
Error	297.269	75	3.964			
Total	19148.000	80				
Corrected Total	1207.950	79				

The analysis of covariance (ANCOVA) results presented in Table 3 was conducted to examine the effect of different methods on students' achievement while controlling for pre-test scores. The overall corrected model was significant, F(4, 75) = 57.441, P< .001. After controlling for pre-test scores, there was a significant main effect of the methods on students' achievement in circle geometry, F(1,75)=2.131,*P*=.000. Since P<0.05, reject the null hypothesis. Thus, there is a significant difference between the mean achievement scores of students taught circle geometry using TPS method and those taught using DIM method in favour of the TPS group.

The analysis of covariance (ANCOVA) results presented in Table 3 was conducted to examine the effect of gender on the students' achievement while controlling for pre-test scores. The overall corrected model was significant, F(4, 75) = 57.441, p < .05. However, after controlling for pre-test scores, there was no significant main effect of gender on the dependent variable, F(1, 75) = .210, p = .648. Since, P > 0.05, the result fail to reject the null hypothesis. Thus, there is no significant difference in the mean achievement scores of male and female students taught circle geometry using Think-Pair-Share instructional strategy.

The analysis of covariance (ANCOVA) results presented in Table 3 was conducted to examine the interaction effects of instructional strategies and gender on students' achievement while controlling for pre-test scores. The overall corrected model was significant, F(4, 75) = 57.441, p < .05. However, after controlling for pre-test scores, there was no significant interaction effect between instructional strategies and gender, F(1, 75) = .977, p = .326. Since, P > 0.05, fail to reject the null hypothesis. Therefore, there is no significant interaction effect of the instructional strategies and gender on students' achievement in circle geometry.

Discussion

Findings from the study show that students taught circle geometry using with think pair share instructional strategy obtained a higher mean gain than those taught using direct instruction method, on testing the

hypothesis, think pair share significantly increases students' achievement in circle geometry in mathematics more than direct instruction method of teaching. These findings agree with the results of Falebita, Ayanwoye and Salami (2022) who investigated the effects of lesson study and think pair share instructional strategies on students' academic achievement in circle geometry. They found that Think-Pair-Share has a significant effect on students' achievement in circle geometry. Similarly, the findings of this study align with the results of Althelab and Omar (2018), who investigated the effect of think pair share strategy on the achievement of second-grade female students in mathematics and their reasoning. The study revealed that students in the experimental group who were taught using think pair share are superior to those in the control group in terms of reasoning and achievement. It also falls in line with the findings of Yusuf, Owede and Bello (2018), who investigated the effects of think pair share instructional strategy on students' achievement in civic education in Bayelsa, Nigeria. The result also revealed that there is a significant improvement of the achievement level of the students in the think-pair-share-classroom over the conventional classroom in terms of the teaching strategy used in delivering the course contents. Chianson, Okwu, and Kurumeh (2015) found that the Think-Pair-Share (TPS) strategy significantly improved secondary students' achievement and academic self-esteem in fractions. Their findings revealed that the notable difference in the mean achievement scores between students taught using the TPS strategy and those taught with conventional methods highlights the effectiveness of the TPS approach.

The findings of this study demonstrate that the Think-Pair-Share (TPS) instructional strategy significantly enhances students' achievement in circle geometry compared to the direct instruction method. The effectiveness of TPS is evident in its ability to actively engage students in the learning process, promoting peer interaction and critical thinking. The consistent improvement in achievement among students taught using TPS suggests that interactive and student-centered teaching methods can be more effective than traditional approaches, particularly in mathematics, where conceptual understanding and problem-solving skills are essential.

With respect to gender, the findings of the study revealed that female students taught circle geometry using think pair share instructional strategy obtained a higher mean gain than their male counterparts.

However, the hypothesis testing indicated no statistically significant difference in the achievement scores of male and female students when taught using TPS, demonstrating that the strategy is gender inclusive. This result suggests that TPS effectively supports learning outcomes for both male and female students, highlighting its suitability for diverse classroom settings.

The findings from the study agrees with the results of Sao (2023) on the efficacy of think pair share in improving the retention ability of secondary school students in biology that there is no significant difference in achievement of male and female students biology using TPS strategy. The outcome of

the analysis showed that there was an interaction effect of the instructional strategies and gender on students' achievement in circle geometry even though the interaction was not statistically significant. This means that the combined effect of instructional strategies and gender on achievement was likely due to random variation and not a meaningful or reliable factor influencing students' post-test means scores in circle geometry. The result of the study is in alignment with Wisdom (2023), whose findings on the effect of think pair share instructional strategies on senior secondary school students' achievement and interest in chemistry, showed that there is no statistically significant interaction effect of gender and teaching techniques (think pair share and Lecture method) on students' academic achievement in chemistry. Similarly, another study by Abiodun, Asanre, Ogundeji, Odupe, and Basaki (2022), whose findings on the effect of Think-Pair-Share (TPS) on students' academic achievement in senior secondary school mathematics showed an interaction effect between TPS and gender on students' achievement in mathematics, but did not specify whether it was statistically significant or not.

Conclusion

Based on the findings of this study, it was concluded that students taught circle geometry using the Think-Pair-Share (TPS) instructional strategy achieved higher mean scores in mathematics achievement test compared to those taught using the Direct Instruction Method. These differences were statistically significant at the 0.05 level, favouring the TPS group. While female students had slightly higher mean scores in achievement than their male counterparts when taught with TPS, these differences were not statistically significant. Additionally, there was no interaction effect between gender and teaching method on students' achievement. Overall, TPS proved more effective than the Direct Instruction Method in improving both achievement for students in circle geometry, regardless of gender.

Recommendations

Based on the findings of the study, the following recommendations were made

1 Since Think-Pair-Share Strategy was found to be an effective teaching strategy for improving students' mean achievement scores in circle geometry, mathematics teachers should adopt it as a teaching strategy in mathematics teaching.

2 Workshops and seminars should be organized for in-service mathematics teachers. Teacher-training institutions should include the use of Think-Pair-Share instructional strategy in mathematics method course contents to ensure the training of the pre-service mathematics teachers in the strategy

3 School owners and principals of public secondary schools should use the stipulated ratio of teacher-student in a class as stated in National Policy of Education (NPE) so as to help the teachers carry out the use of Think-Pair-Instructional Strategy effectively.

REFERENCES

Ahmad, S. Z. (2016). The Flipped Classroom Model to Develop Egyptian EFL Students' Listening Comprehension. *English language teaching*, *9* (9), 166-178.

Ajani, T. O. and Olabode, J. O. (2018). Influence of collaborative learning on students' achievement in Mathematics in Abeokuta south local government, Ogun state. *ABACUS (Mathematics Education Series)*, *43* (1), 81-88.

Althelab, S. H. and Omar, T. G. (2018). The impact of think–pair–share strategy on the achievement of second grade intermediate female students in mathematics and their reasoning thinking. *Faraaheedi Journal*, *17*, 312-333.

Arnigo, J. C., Exzequel, L., Manalo, M. J., Pacheco, V. L., Bea S. A. and Elipane.. L. (2018) "Utilizing lesson study in teaching circles." *Advanced Science Letters* 24 (11), 7876-7879.

Bal R. (2017). Playing the indicator game: reflections on strategies to position an STS group in a multi-disciplinary environment. *Technology and society*, *3*, 41-52

Chiansm, M.M, Okwu, I. E. and Kurumh, M. S. (2015). Effects of think-pair share strategy on Secondary School. Mathematics Students Achievement and Academic Self-Esteem in Fractions. *American International Journal of Contemporary Scientific Research*, 2(2), 141-147.

Falebita, D. E., Saviour, M. K., Jaiyeola, J. I., Ojo, O. A. and Adepelumi, A. A. (2019). Discrimination of Post-Stack Bright Spots Using Avo and Model-Based Inversion Technique, Coastal Swamp Niger Delta, Nigeria-A Case Study. *Petroleum & Coal*, *61*(6).

Falebita, O. S., Ayanwoye, O. K. and Salami, O. O. (2022). Effects of lesson study and think-pair-share instructional strategies on students' academic performance in circle geometry. ABACUS (Mathematics Education Series).47 (2), 140-156

Farrajallah, A. E. K. (2017). The Impact of Employing the Think-Pair-Share Strategy to Gain Some Number Sense Skills and Mathematical Communication Skills Among Fifth Grade Students. *An-Najah University Journal for Research-B (Humanities)*, *31* (9), 1627-1663.

Hasanah,F. A. and Surya, E. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education*, *8*(1), 85-94.

Hissan, Y. and Ntow, F. D. (2021). An investigation into the effect of concept-based instruction on senior high school students' geometric thinking and achievement in circle theorem. *International Journal of Research and Innovation in Social Science. https://www*. *Rsisinternational.org/journalsLibrary*, *5*, 52-60.

Mekonnen, A. (2014). Economic costs of climate change and climate finance with a focus on

Africa. *Journal of African Economies*, *23*(suppl_2), ii50-ii82.

Mollakuqe, V., Rexhepi, S. and Iseni, E. (2020). Incorporating Geogebra into teaching circle

properties at high school level and it's comparison with the classical method of

teaching. *International Electronic Journal of Mathematics Education*, *16*(1), em0616.

Napitupulu, W. R. and Surya, E. (2017). *Character education role in learning mathematics as*

generation formers anticorruption.

National Business and Technical Education Board (NABTEB) Chief Examiners Report

(2012, 2019) on Mathematics. Benin City, Edo state, Nigeria.

Steinmayr, R., MeiBner, A., Weidinger, A. F. and Werthwein, L. (2015). Academic

achievement. Oxford Index. Retrieved from

www.oxfordbibliographies.com/view/d.

Timayi, J. M., Bolaji, C. and Kajuru, Y. K. (2015). Effects of Jigsaw IV cooperative learning

strategy (J4CLS) on academic performance of secondary school students in

geometry. *International Journal of Mathematics Trends and Technology- IJMTT*, *28*.

Unodiaku, S. S. (2018). Teaching geometrical and mensuration proofs with origami-based

instrumental model approach among seniorsecondary school students in Enugu

state. *ABACUS (Mathematics Education Series)*, *43*(1), 14-24.

West African Examination Council (WAEC) (2018), (2019), (2020), (2021), (2022), (2023).

Chief Examiners Report on strength and weakness of Mathematics on circle geometry Lagos:

Nigeria.

Wisdom, F.M (2023). Effect of Think Pair Share Instructional Strategy on Senior Secondary

School Students Academic Achievement and Interest in Chemistry in Akwa Ibiom State.

Unpublished MSc. project, Department of Science Education, Nnamdi Azikiwe University,

Awka.

Yang and Chen, X. (2013). STEM Attrition: College Students' Paths into and out of STEM

Fields. Statistical Analysis Report. NCES 2014-001. *National Center for Education*

Statistics.

Yusuf, A., Owede, V. C. and Bello, M. B. (2018). Effect of Think-Pair-Share instructional

strategy on students' achievement in civic education in Bayelsa, Nigeria. *Anatolian journal*

of education, *3* (2), 47-62