



IMPROVING PUPILS' ACHIEVEMENT IN FRACTION USING INQUIRY-BASED INSTRUCTIONAL STRATEGY ENRICHED WITH ORIGAMI ACTIVITIES

Adedeji Tella^{1*}, Folasade Amina Sulaimon²

^{1,2}Department of Science and Technology Education, University of Ibadan, Ibadan, Nigeria

*Corresponding author: dejtell@gmail.com

Article Info

Article history:

Received: May 20, 2022
 Accepted: October 4, 2022
 Published: November 16, 2022

Keywords:

Inquiry-based instructional strategy
 Origami activities
 Pupils' achievement in fraction

ABSTRACT

This study determined the effects of inquiry-based instructional strategy enriched with origami activities and the moderating effect of gender on pupils' achievement in fraction in Oyo State, Nigeria. The study adopted the pretest-posttest control group quasi-experimental design using a 2x2 factorial matrix. The sample group consisted of 55 boys and 33 girls from two randomly selected public primary schools. Two intact classes were randomly assigned to experimental and control groups. The instruments used were pupils' achievement test in fraction and teachers' instructional guides. Data were analysed using analysis of covariance, as well as estimated marginal mean. Treatment had a significant main effect on pupils' achievement in fraction and there was no significant main effect on gender. Treatment and gender had no significant interaction effect on pupils' achievement. It was recommended that mathematics teacher should adopt inquiry-based instructional strategy enriched with origami activities.

MENINGKATKAN PRESTASI SISWA DALAM PECAHAN MENGGUNAKAN STRATEGI INSTRUKSIONAL BERBASIS INQUIRY YANG DIPERKAYA DENGAN KEGIATAN ORIGAMI

Kata Kunci:

Strategi Pembelajaran Berbasis Inkuiri
 Aktivitas origami
 Prestasi belajar pada pecahan

ABSTRAK

Penelitian ini bertujuan untuk menentukan efek dari strategi pembelajaran berbasis inkuiri yang diperkaya dengan kegiatan origami dan efek moderasi gender terhadap prestasi siswa dalam pecahan di Negara Bagian Oyo, Nigeria. Penelitian ini mengadopsi desain eksperimen semu kelompok kontrol pretest-posttest dengan menggunakan matriks faktorial 2x2. Kelompok sampel terdiri dari 55 anak laki-laki dan 33 perempuan dari dua sekolah dasar negeri yang dipilih secara acak. Dua kelas utuh secara acak ditugaskan ke kelompok eksperimen dan kontrol. Instrumen yang digunakan adalah tes hasil belajar siswa pada pecahan dan buku petunjuk guru. Analisis data menggunakan analisis kovarians, serta estimasi marginal mean. Perlakuan memiliki pengaruh utama yang signifikan terhadap prestasi belajar siswa pada pecahan dan tidak ada pengaruh utama yang signifikan terhadap jenis kelamin. Perlakuan dan jenis kelamin tidak memiliki pengaruh interaksi yang signifikan terhadap prestasi belajar siswa. Direkomendasikan kepada guru matematika untuk mengadopsi strategi pembelajaran berbasis inkuiri yang diperkaya dengan kegiatan origami.

1. INTRODUCTION

Mathematics is a central part of all efforts at knowledge that human cannot live effectively without. Mathematics is described as the pillar of all knowledge showing its relevance to all disciplines. Mathematics relates to everything in the universe from the smallest to the largest [1]. Mathematics is the science of structure, order, numbers, spaces, and quantities [2]. Mathematics is a relationship that revolves around the elementary practice of counting, measuring and description of shapes and objects. Mathematics is the bedrock and indispensable tool for scientific, technological and economic advancement of any nation [3], [4]. Mathematics is intimately connected to daily life and everyone's life-long planning/experiences [3]. Emphasis on sound mathematical knowledge for pupils and students in primary and secondary schools is therefore for learners to be able to reap the benefits of acquisition of mathematical skills, live a better life and also be in a better position to directly or indirectly contribute to the development of the society and the world's economy [5].

Nigerian education curriculum sees primary education as the compulsory education given to children aged 6-12 years and the rest of the education system is built on it [6]. Teaching mathematics in primary schools will lay foundation for pupils for their future advance studies in mathematics, as well as in other school subjects that requires the knowledge of mathematics. With this assertion, it can be concluded that the knowledge of mathematics at the primary school level is of great importance, especially in the day to day life of every citizens. No matter the profession one venture into in life, one will still need mathematics. The main goal of teaching mathematics at the primary school level is to help pupils to acquire: basic skills in numeracy; ability to use these skills to solve problems; ability to estimate and make or calculate approximations and ability to interpret graphs and arrangements of numerical data.

Fraction is an important aspect of numeracy in primary school mathematics and it refers to a number that represents a measure of the relationship between two quantities, these two quantities provide information about the parts, the units and the whole. Fractions can represent different concepts such as: the part of a whole; a proportion; or a magnitude that can be placed on a number line [7]. Fractions are important for physical, biological, and social sciences and in a wide range of middle-income occupations that do not require advanced mathematics including nursing, carpentry, and auto mechanics [8], [9]. A shaky grounding in fractions can prevent individuals from pursuing advanced mathematics and shut pupils off from a significant number of career opportunities in later life [10]. Learners' competency in numeracy and literacy in early grades affects their academic achievement more generally in later years and affects how they master other subjects [11]. Knowledge of fraction is essential in understanding measurement, algebra, rational numbers and time concept, to mention a few.

Despite these importance, fraction as a concept in mathematics still poses a lot of challenges to both teachers and pupils in primary schools in Nigeria. Fractions were identified as one of the three most difficult topics to teach and learn in primary school mathematics curriculum [12]. Fractions involve difficult-to-learn and difficult-to-teach concepts that present ongoing pedagogical challenges to the mathematics education community. These difficulties begin early in the primary years [13] and persist through middle school, then into secondary and even tertiary education [14]. Historically, fractions have been one of the most difficult skill to master [15]. Students perceived fractions as parts of the sets rather than parts of the whole [16]. If students experience difficulties with fractions, they will have problems with other domains in mathematics such as algebra, measurement, and ratio and proportion concepts [17].

The observed low performance of students in fraction cum mathematics has been traced to various factors, including lack of interest [18], ineffective course-delivery strategies adopted by teachers [19], [20], weak foundation, at the formative stage of the students' education [21], reasoning and numerical abilities [22], contents the students are required to learn, as well as the instructional approach used by teachers [23]. Poor teaching methods are the main factor contributing to students' poor performance in fractions [24], [25]. Despite this, many teachers still use the traditional (conventional) mode which relies heavily on textbooks, charts and diagrams to teach mathematics including fraction. A lot of new and modified methods have been proposed to improve performance in fraction, these includes measurement approach [26], e-learning approach [27], geogebra [28] among others.

Inquiry-based Learning is learning through questions and experimentations [29]. It also creates a "culture of inquiry" as "teachers become learners, learners are self and peer-taught and everyone becomes a researcher" [30]. Inquiry-based learning is an active learning approach which gives students the opportunity to experience an authentic version of the subject and get a taste of high level mathematical work [31]. There have been many attempts to strengthen the learning of mathematics through the adoption of a teaching approach that emphasizes inquiry [32]. Inquiry-based learning is emphasizing the responsiveness, authenticity, and intellectual engagement that make this approach a useful, means of ensuring that students get the most out of their shared learning environment [33]. The strategy actively involves students in the learning process and allows them to learn the contents on their own, which provides more opportunities for them to gain a deeper understanding of the concepts and become better critical thinkers [34].

Several studies have revealed that students taught through inquiry scored higher than those taught with the traditional method [35], [36]. Inquiry based mathematics instruction improved students' achievement in mathematics [37]. Inquiry-based learning has also been found to support higher level cognitive interaction [38]-[40], longer-term knowledge retention [41], [42], and more efficient collaboration [43]. However, there are few studies on effect of Inquiry-based learning strategy enriched with origami activities on pupils' achievement in mathematics especially in fraction in Nigeria.

The importance of origami in the teaching and learning of fraction cannot be over emphasized. Origami is common word in Japanese, "ori" means "to fold", and "gami" means "paper". It is thus known as Japanese art of paper folding. Origami is a bridge between nature and mathematics [44], [45]. Origami takes great mathematical potential when used in education [46] especially in geometry [47]. Origami activities in geometry lessons improved high school students' achievement in geometry [48], it is also helpful in students' mathematical problem solving abilities [49].

Origami-based mathematics instruction significantly increased students' spatial ability scores [50]. Aside geometry, origami can be used to learn fractions, algebra, spatial visualisation, sequence and trigonometry. However, studies using origami activities on pupils' achievement in fraction in Nigeria is replete.

Researchers have identified gender as one of the variables influencing instructional strategy. Gender difference is a recurring issue in mathematics instruction. Many research findings show that, a significant difference in mean achievement of students in mathematics is in favour of male. Such findings are seen in [51]-[55] among others. There is also argument that male superiority over female is virtual because the female only see mathematics as a domain of the male. There is no significant relationship between gender and achievement in mathematics [56], [57]. This inconsistency in gender issues calls for further investigation in this study. This study, therefore, determined the effect of inquiry-

based instruction enriched with origami activities on pupils' achievement in fraction, as well as the investigation of gender.

Despite the importance attached to fraction in everyday life activities, pupils experience difficulty in learning fraction, when compared to other aspects of mathematics. Studies have revealed that strategy adopted by teachers (which is mainly conventional strategy) is a major factor of learners' achievement. It was observed that the conventional approach did not help in improving pupils' achievement in fraction. In an attempt to remediate the recurring poor achievement in fraction, researchers have focused on different instructional strategies such as Measurement approach, Geogebra, Computer Games, E-learning approach. However, very few studies have been carried out on incorporation of origami activities into Inquiry-Based Instructional Strategy coupled with gender investigation.

Inquiry-Based Instructional Strategy is an approach to teaching and learning that places students' question, ideas and observations at the centre of the learning experience. This method is not vast in practice by mathematics teachers, but offers active learning environments that engage learners and improves their reasoning skills. This study, therefore, determined the effect of inquiry based instruction enriched with origami activities on pupils' achievement in fraction as well as examining the moderating effect of gender.

Research on learning mathematics with origami activities has been carried out several times by other researchers, including; origami boxes to explore the concepts of geometry and calculus [45], origami instructions for geometry knowledge [46], origami to improve mathematical problem solving [49], origami to learning mathematics for the deaf [1], origami to spatial intelligence [2] but, research on origami activities using instructional strategies has never been done. However, in this study, research on instructional strategies is a novelty. This study also uses inquiry-based learning, which has never been done before through origami activities. This research aims to improve student achievement with inquiry-based instructional strategies through origami activities.

2. METHOD

This study adopted the pretest-posttest control group quasi-experimental research design using 2 x 2 factorial matrix. This study covered basic three pupils in two public schools in Akinyele Local Government Area of Oyo State Nigeria. The topic selected for the experiment was fraction, while sub-topics included fraction of shapes, unit fractions, equivalent fractions and ordering of fractions. These were as contained in 9-year basic education curriculum: mathematics for primaries 1-3 [58]. Convenient random sampling was used to select two primary schools in Akinyele Local Government Area of Oyo state, Nigeria. Two intact Basic three classes, one from each school were used for this study. The schools were selected based on the following criteria:

- a. The schools must be public schools
- b. The schools must have experienced teachers who possessed teaching qualification
- c. The mathematics teachers must be willing to involve in the experiment.

The instruments used for the study are;

- a. Pupils' Achievement Test in Fraction (PATF)
- b. Teachers' Instructional Guide on Inquiry-Based Instructional Strategy enriched with Origami Activities (TIGISOA)
- c. Teachers' Instructional Guide on Conventional Instructional Strategy (TIGCIS)
- d. Evaluation Sheet for Assessing Teachers' Performance during Training (ESATPT)

The PATF was adapted from Mathematics Association of Nigeria Mathematics textbook for primary three, to measure pupils' achievement in fraction. It consisted of two sections; section A contained questions that sought personal data about pupils such as: name of school, class, sex and age while section B consisted of 15 multiple choice items with options A-D. The Pupils' Achievement Test in Fraction (PATF) was validated by experts in test Construction. The reliability of the instrument was determined by administering the Fraction Achievement Test to a sample of 40 pupils selected outside the target sample. The reliability coefficient was ascertained using Kuder-Richardson formula (K-R₂₀) and this yielded a value of .72 which was found suitable for the experiment/ study.

The pupils in the experimental group received lessons in fraction using inquiry-based instructional strategy enriched with origami activities. Instructional resources included origami papers, crayon, ruler and pencil. The teachers' instructional guide on inquiry-based instructional strategy enriched with origami activities was validated by experts. There were many pupils' activities embedded in the TIGIISOA. The pupils in the control group received lessons in fraction using conventional instruction only (without origami activities). This instructional guide was teacher- dominated. The TIGCIS was validated by experts for its uniformity. The ESATPT was developed to assess research assistants before enlisting them. This was designed to evaluate the trained teachers' effective use of the instructional guide during the teaching. It was divided into two sections: section A consisted of personal data of teachers; while section B is made up of different stages of instructional strategy to be assessed, with a format of a-5 point rating scale, from very-good (5) to very poor (1).

The validity of the instrument was carried out by experts in test construction and mathematics educators. The instrument was used by three raters to assess the performance of teachers on the use of the two strategies in teaching fraction. The inter-rater reliability indexes of the instruments were determined using Scott pie (Scott π) which gives .79 and .72 for inquiry-based instructional strategy enriched with origami activities and conventional instructional strategy respectively.

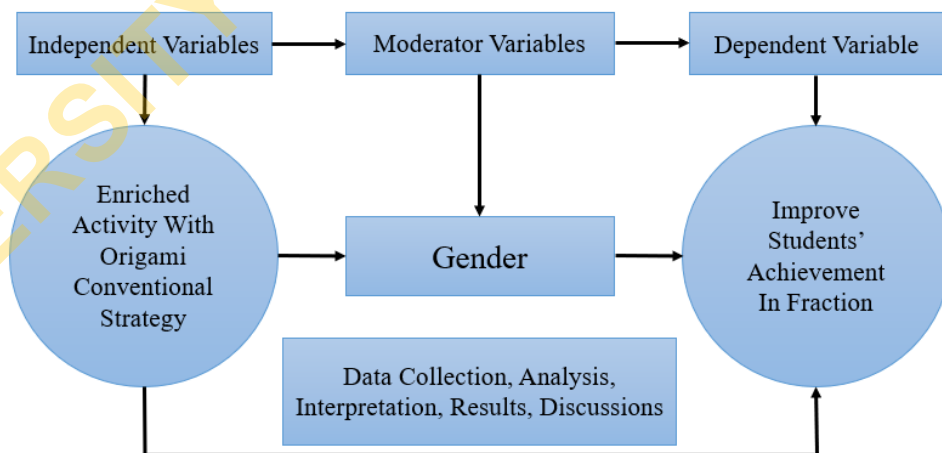


Figure 1. Study flowchart

The regular mathematics teachers of the two intact classes were trained as research assistants for a week. All pupils completed the pupils' achievement test in fraction as pre-test before the commencement of treatment. Application of treatment lasted four weeks. The two intact basic three classes were assigned to treatment and control group randomly. The pupils were taught by their regular mathematics teachers trained for the purpose, under the supervision of the researcher. The duration of the lesson was 45 minutes daily. The

topic used for the study was fraction and subtopic included: unit fractions, fraction of shapes, equivalent fractions, and ordering of fractions.

All pupils completed Pupils' Achievement Test in Fraction (PATF) as posttest (same as pretest) after the completion of treatment. The data collected were analysed using Analysis of covariance at .05 level of significance.

3. RESULTS AND DISCUSSION

H₀₁: There is no significant main effect of treatment on pupils' achievement in fraction

Table 1. Analysis of Covariance (ANCOVA) Showing the Effect of Treatment and Gender on Achievement in Fraction

Source	TYPE III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	85.280 ^a	4	21.320	6.010	.000	.225
Intercept	480.380	1	480.380	135.417	.000	.620
Pretest	0.523	1	.523	.147	.702	.002
Treatment	76.714	1	76.714	21.625	.000*	.207
Gender	7.013	1	7.013	1.977	.163	.023
Treatment x Gender	5.037	1	5.037	1.420	.237	.017
Error	294.436	83	3.547			
Total	3755.000	88				
Corrected Total	379.716	87				

R Squared = .23 (Adjusted R Squared = 0.19) *denotes significant at .05 level of significance

Table 1 shows that there is a significant main effect of treatment on pupils' achievement in fraction ($F_{(1,87)} = 21.63$, partial $\eta^2 = .21$, $p < .05$). The effect size is 21%, this indicates a significant improvement in the pupils' achievement in fraction after the intervention. This implies that the null hypothesis 1 was rejected. Consequent upon the observed main effect, the marginal means is used to determine the mean post-achievement scores of pupils in each of the groups (experimental and control) as shown in Table 2.

Table 2. Estimated Marginal Means for Post-Achievement Scores by Treatment

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental group	7.17	.29	6.60	7.74
Control group	5.22	.31	4.61	5.83

Table 2 shows that the experimental group had a higher adjusted post-achievement mean score (7.17) compared to the control (5.22) group. The difference is in favour of inquiry-based instruction enriched with origami activities. This implies that pupils taught using inquiry-based instructional strategy enriched with origami activities had a higher achievement in fraction than those taught using the conventional instructional strategy.

H₀₂: There is no significant main effect of gender on pupils' achievement in fraction. The result from Table 2 reveals the main effect of gender on pupils' achievement in fraction was not significant ($F_{(1, 83)} = 1.98$, $p > .05$) at 0.05 level of significance. The null hypothesis of no significant main effect of treatment of gender on pupils' achievement in fraction was not rejected. However the slight difference achievement based on gender was presented in Table 3.

Table 3. Estimated Marginal Means of Post-Achievement Scores by Gender

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Boys	5.90	.26	5.39	6.41
Girls	6.49	.33	5.83	7.14

Table 3 shows that the girls had a slightly higher adjusted post-achievement mean score (6.49) than the boys (5.90). The mean difference (.59) was in favour of the girl, although the difference is not statistically significant. This indicates that gender (whether pupils are boy or girl) does not have significant effect on pupils' achievement in fraction.

Ho₃: There is no significant interaction effect of treatment and gender on pupils' achievement in fraction. The results in Table 1 revealed that the interaction effect of treatment and gender is not significant ($F_{(1,83)} = 1.42, p > .05$). The null hypothesis which states that there is no significant interaction effect of treatment and gender on pupils' achievement in fraction is retained. Hence, treatment and gender has no interaction effect on pupils' achievement in fraction.

The discussions of the findings were thus stated; The treatment contributed a substantial change as observed in the achievement gain after the intervention. The experimental group exposed to inquiry-based instruction enriched with origami activities recorded higher marginal means scores compared to their counterpart in the control group. This may be due to the fact that inquiry-based instructional strategy is learner-centred full of activities which allows pupils to interact with the teaching materials through hands-on and minds-on activities during instruction process.

This finding agrees with Ferguson [37], who demonstrated that inquiry based mathematics instruction improves students' achievement in mathematics. Students exposed to inquiry-base instruction approach scored significantly higher in mathematics than their counterpart who were exposed to traditional method of instruction [35], [36], [59], and [60]. This result is in line with studies which have demonstrated that inquiry based learning has been found to support higher-level cognitive interaction [39], longer-term knowledge retention [41], [42], and more efficient collaboration [43].

The result revealed that there was no significant main effect of gender on pupils' achievement in fraction. The result of this study is in line with the findings of [61] who found that male and female did not significantly differ in achievement and retention in mathematics achievement. There was no significant difference in male and female achievement and retention when taught using origami [62]. Likewise, no significant difference in the mean achievement scores of male and female taught using origami [63]. There was no significant difference in the performance of male and female students in mathematics [64]. This is in contrast with the studies which reported gender difference in mathematics learning where males were said to be superior [53]-[55], [65], [66]. More so, the findings of this study revealed that girl child had a higher mean score than their boy counterparts in their achievement in fraction, although the difference was not significant. This implies that inquiry-based strategy as well as origami is gender friendly and effective in the teaching and learning of fractions.

The result of findings showed that there was no significant interaction effect of treatment and gender on pupils' achievement in fraction. That is, the treatment is not gender biased. It agrees with the finding of research who found that there was no significant interaction effect between group and gender in paper folding test and surface development test [46]. This finding contrast at the study of research which demonstrated that the moderating effect of gender among students was significant [37]. [46] also revealed significant interaction effect between group and gender in card rotation test.

4. CONCLUSION

Based on the findings of the study, it was established that the inquiry-based instruction enriched with origami activities produced pupils with significantly higher achievement in fraction than those pupils that were taught using conventional teaching method. The study has also shown that the influence of gender was not significant, although girl child demonstrated a slightly higher level of achievement in fraction. Lastly, gender had no moderating effect on achievement in fraction. The study has some educational implications for pupils, teachers and curriculum planners. Active participation of pupils in the class aids achievement and makes the lesson more meaningful. This study has implications on teachers who should adopt inquiry method of teaching, as well as origami activities which engages pupils in the learning process. It allows pupils to explore, discover, draw conclusions, reflect, evaluate and report their findings. Pupils learn better when they are involved in the learning activity. Inquiry-based instruction enriched with origami activities enhance pupils understanding of fraction and develop higher-order thinking skills. The findings of this study also have implication on the curriculum planners who are expected to plan for conceptual change over period of years.

Based on the findings of the study, it is recommended that mathematics teachers should adopt inquiry-based instructional strategy enriched with origami activities in the teaching of fractions to improve pupils' achievement in fraction. This study proved that inquiry-based instructional strategy enriched with origami activities would bridge the gender gap in pupils' achievement in fraction by providing equal opportunities for both boys and girls to interact with teachers, amongst themselves and the resources. Ministry of Education and professional organisations like Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN), National Educational Research and Development Centre (NERDC), should organise in-service trainings like workshops, seminars and conferences for mathematics teachers to enhance and make them acquire better instructional strategies.

REFERENCES

- [1] C. Mefor, *Nigeria: Identifying Problems of Poor Performance in Mathematics and Way out*, Njoro: Egerton University Press, 2014.
- [2] B. O. Soyemi and O.S. Jegede, "Student dictionary of mathematics (rev. ed)," *Wiseword Associates Publication*, vol. 1, no. 1, pp. 11-23, 2000.
- [3] M. A. Umameh, *A survey of factors responsible for students' poor performance in mathematics in senior secondary schools certificate examination (SSCE) in Idah Local Government Area of Kogi State, Nigeria*, Benin : University of Benin, 2011.
- [4] T, Tshabalala, and A. C. Ncube, "Causes of poor performances of ordinary level pupils in mathematics in rural secondary schools in Nkayi districts; learners' attritions," *Nova Journal of Medical and Biological Sciences*, vo. 1, no.1, pp. 1-6, 2013.
- [5] U. S. Anaduaka, *Acquisition of mathematical knowledge for sustainable development: Implication for teaching and learning*. In Talla, N.S., Mohammed, M. H., Aparu, S. A. E. and Ogungbe, E. O. [Eds]. *Education for Sustainable Development in Nigeria*. A Publication of the Faculty of Education and Arts, IBB University, Lapai, Niger State. 237-247, 2010.
- [6] F. Republic of Nigeria, *National policy on education, 6th edition*. Lagos : Federal Government Press, 2013.
- [7] M. J. Behr, R. Lesh, T. R. Post, and E. A. Silver, "Rational-number concepts," *Acquisition of mathematics concepts and processes*, vol. 4, no. 1, pp. 91–125. New York: Academic Press, 1983.

- [8] C. Hoyles, R. Noss, and S. Pozzi, "Proportional reasoning in nursing practice," *Journal for Research in Mathematics Education*, vo. 32, no. 1, pp. 4-27, 2001.
- [9] T. Sformo, *Practical problems in mathematics: For automotive technicians*. Independence, KY: Cengage Learning, 2008.
- [10] C. Bruce, D. Chang, and T. Flynn, *Foundations to Learning and Teaching Fractions: Addition and Subtraction*. Ontario : Curriculum and Assessment Branch Ontario Ministry of Education, 2013.
- [11] M. Oketch, M. Mutisya, M. Ngware, and J. Sagwe "Teacher math test scores: Classroom teaching practices and student achievement in Kenya", Nairobi : Shelter Afrique Center, 2010.
- [12] P. H. Ong, B. R. Muhamad, P. Walaiporn, A. Wilai and H. R. Wakidi, *Diagnostic assessment of teacher trainee's content abilities and perception of teaching fraction and decimals*. Penan : SEAMEO-RECSAM, 1992.
- [13] S. Empson, and L. Levi, *Extending children's mathematics: Fractions and decimals: Innovations in cognitively guided instruction*. Portsmouth, NH: Heinemann. 178-216, 2011.
- [14] G. Orpwood, L. Schollen, G. Leek, P. Marinelli-Henriques, and H. Assiri, *College Mathematics Project. Ministry of Education and the Ontario Ministry of Training, Colleges and Universities*. Toronto: Seneca College of Applied Arts and Technology, 2011.
- [15] R. Misquitta, R. "A review of the Literature: Fraction Instruction for Struggling Learners in Mathematics," *Learning Disabilities Research and Practices*. vol. 26, no. 2, pp. 107-119, 2011.
- [16] P. Gould, L. Outhred, and M. Mitchelmore, *Conference proceedings of the 2006 meeting of the Mathematics Education Research Group of Australia (MERGA), Australia*, 2006.
- [17] S. J. Lamon, *Rational numbers and proportional reasoning: Towards a theoretical framework for research*, Charlotte : Information Age Publishing, 2007.
- [18] J. C. Amazigo, *Mathematics phobia diagnosis and prescription*. Abuja : National Mathematics Centre first annual lecture, 2000.
- [19] C. C. Ogbonna, *Effects of Constructivist Instructional approach on Senior Secondary School Students Achievement and interest in Mathematics*. Nigeria : Unpublished M.Ed Thesis University of Nigeria Nsukka, 2004.
- [20] U. Nzewi, U. *Strategies for teaching erosion in formal setting: environmental education project series*. Nigeria : Science Teachers' Association of Nigeria, 2000.
- [21] M. S. Kurumeh, M. S. "Effect of ethno-mathematics approach on students' achievement in geometry and menstruation," *J. Mathematical Association of Nigeria*, vol. 31, no. 1, pp. 35-44, 2006.
- [22] M. A. Adeleke, Gender Disparity in Mathematics Performance Revisited. Can Training in Problem Solving Bring Difference Between Boys and Girls? *Journal of Mathematics Education*. Vol. 21, no. 32, pp. 1-7, 2007.
- [23] R. White-Clark, M. DiCarlo and S. N. Gilchrist, "Guide on the side": An instructional approach to meet mathematics standards. *The High School Journal*, vol. 9, no. 4, pp. 40-44, 2008.
- [24] O. T. Okafor, *Teaching Methods of Mathematics in Secondary Schools*. Ibadan: Special Book Ltd. (Chapter 4), 2002.
- [25] E. A. C. Okeke, *Women in science, technology and mathematics education in Nigeria*. Keynote Address Delivered in Uche Nzewi (ed.), 42nd Annual Conference of Science Teachers Association of Nigeria, 3 – 11, 2006.

- [26] G. Bobos and A. Sierpinska, "Measurement approach to teaching fractions: A design experiment in pre-service course for elementary teachers," *International Journal for Mathematics Teaching and Learning*, vol. 18, no. 2, pp. 203-239, 2017.
- [27] T. S. Ali Thabet and N. V. Kalyankar, "The Effect of E-Learning Approach on Students' Achievement in Fraction Math Course Level 5 at Yemen's Public Primary School," *Global Journal of Computer Science and Technology: E Network, Web and Security*. vol. 14, no. 2, pp. 44-52, 2014.
- [28] N. Thambi and L. K. Eu, "Effect of Students Achievement in Fraction using Geogebra," *SAINSAB* vol. 16, no. 1, pp. 97-106, 2013.
- [29] I. Ajit, M. Ramesh and G. Arun, "Higher Order Thinking Skills through Online Discount Coupons," *Journal of Recent Research and Applied Studies*. vol 3, no. 5, pp. 71-74, 2016.
- [30] C. Gordon, "The culture of inquiry in school Libraries," *School Libraries Worldwide* vol. 16, no. 1, pp. 73–88, 2010.
- [31] J. Boaler, *The Elephant in the Classroom: Helping Children Learn and Love Maths*. London: Souvenir Press, 2009.
- [32] K. Maaß and M. Artigue, "Implementation of inquiry-based learning in day-to-day teaching: a synthesis," *The International Journal of Mathematics Education*, vo. 45, no. 6, pp. 779-795, 2013.
- [33] L. Caputo, *Inquiry Based Learning for EAL (English for Additional Language)*. Bingley : Emerald Group Publishing Limited, 2014
- [34] H. Wang and L. Posey, "An inquiry-based linear algebra class, online submission," *US-China Education Review*, vol. 1, no. 1, pp. 489-494, 2011.
- [35] D. B. Crawford and E. Snider, "Effective mathematics instruction: the importance of curriculum," *Education and Treatment of Children*, vol. 23, no. 2, pp. 122-142, 2000.
- [36] J. E. Riordan and P. E. Noyce, P. E. "The impact of two standards based mathematics curricula on 63 student achievement in Massachusetts," *Journal for Research in Mathematics Education*, vol. 32, no. 4, pp. 368-398, 2001.
- [37] K. Ferguson, *Inquiry Based Mathematics Instruction versus Traditional Mathematics Instruction: The Effect on Student Understanding and Comprehension in an Eighth Grade Pre-Algebra Classroom*. Ohio : Caderville University, 2010.
- [38] J. Marshall and R. Horton, "The relationship of teacher facilitated, inquiry-based instruction to student higher-order thinking," *School Science and Mathematics*, vol. 111, no. 3, pp. 93-103, 2011.
- [39] R. Bruder and A. Prescott, "Research evidence on the benefits of IBL" *The International Journal of Mathematics Education*, vol. 45, no. 6, pp. 811-822, 2013.
- [40] R. E. Yager and H. Akcay, "The advantages of an inquiry approach for science instruction in middle grades," *School Science and Mathematics*, vol. 110, no. 1, pp. 5-12, 2010.
- [41] D. D. Minner, A. J. Levy and J. Century, "Inquiry-based science instruction: What is it and does it matter? Results from a research synthesis years 1984 to 2002," *Journal of Research in Science Teaching*, vol. 47, no. 4, pp. 474-496, 2010.
- [42] Y. Song and S. C. Kong, S. C. "Going beyond textbooks: A study on seamless science inquiry in an upper primary class," *Educational Media International*, vol. 51, no. 3, pp. 226–236, 2014.
- [43] H. Timperley, L. Kaser and J. Halbert, *A framework for transforming learning in schools*. Melbourne : Innovation and the spiral of inquiry, 2014.
- [44] J. Georgeson, "Fold in Origami and Unfold Math". *Mathematics Teaching in Middle School*, vol. 16, no. 6, pp. 354-361, 2011.

- [45] A. Wares, "Using Origami Boxes to Explore Concepts of Geometry and Calculus", *International Journal of Mathematical Education in Science and Technology*, vol. 42 no. 2, pp. 264-272, 2011.
- [46] N. Boakes, "Origami Instruction in the Middle School Mathematics Classroom: Its' Impact on Spatial Visualization and Geometry Knowledge of Students," *RMLE Online* vol. 32, no. 7, pp. 1-12, 2009.
- [47] V. Cornelius and A. Tubis, "On the Effective Use of Origami in the Mathematics Classroom". In R. J. Lang (Eds.), *Origami 4: Fourth international meeting of origami Science, Math, and Education*, 507-515. Natick, MA: A. K. Peters, 2009.
- [48] S. Arıcı and F. Aslan-Tutak, "The effect of origami based instruction on spatial visualization, geometry achievement, and geometric reasoning," *International Journal of Science and Mathematics Education*, vol. 1, no. 1, pp. 179-200, 2015.
- [49] R. Robichaux and P. Rodrigue, "Using origami to promote geometric communication. *Mathematics teaching in the middle school*, vol. 9, no. 4, pp. 222-229, 2003.
- [50] S. Çakmak, M. Işıksal and Y. Koç, "Investigating Effect of Origami Based Mathematics Instruction on Elementary Students' Spatial Skills and Perceptions," *The Journal of Educational Research*, vol. 107, no. 1, pp. 59- 68, 2014.
- [51] H. N. Odogwu, "The Mathematics teacher factor in the achievement of the goals of the universal basic education (UBE)," *ABACUS: The Journal of Mathematical Association of Nigeria (MAN)*, vol. 27, no. 1, pp. 72 – 79, 2002
- [52] U. J. Udousoro, "The Effects of Gender and Mathematics Ability on Academic Performance of Students in Chemistry," *African Research Review, International Multidisciplinary Journal*, vol. 5, no. 4, pp. 201-213, 2011.
- [53] S. A. Alio and V. F. Harbor-peters, "The effect of Polya's problem solving technique on secondary school students' achievement in mathematics," *ABACUS: Journal of the Mathematical Association of Nigeria*, vol. 25, no. 1, pp. 20-25, 2002.
- [54] I. Galadima, "Gender inequality in algebraic word problems solving performance amongst secondary school students of Sokoto," *Nigerian Journal of Curriculum Studies*, vol. 10, no. 2, pp. 457-460, 2003.
- [55] S. A. Ifamuyiwa, "Problems Facing Mathematics Teaching and Learning in Nigeria *Journal of Curricular Studies*," vol. 6, no. 1, pp. 51-55, 2007.
- [56] S. O. Adebule, "Gender differences on a locally standardized anxiety rating scale in mathematics for Nigerian secondary schools in Nigerian," *Journal of Counselling and Applied Psychology*, vo. 1, no. 1, pp. 22-29, 2004.
- [57] P. O. Abiam and J. K. Odok, "Factors in students' achievement in different branches of secondary school mathematics," *Journal of Education and Technology*, vol. 1, no. 1, pp. 161-168, 2006.
- [58] National Educational Research and Development Centre. (2007). *9-Year Basic Education Curriculum: Mathematics for Primaries 1-3*.
- [59] T. Mensah-Wonkyi and E. Adu, "Effect of the inquiry-based teaching approach on students' understanding of circle theorems in plane geometry," *African Journal of Educational Studies in Mathematics and Sciences*, vol. 12, no. 1, pp. 61-73, 2016.
- [60] K. Salim and D. Tiawa, "Implementation of structured inquiry based model learning towards students' understanding of geometry" *International Journal of Research in Education and Science (IJRES)*, vol. 1, no. 1, pp. 75-83, 2015.
- [61] J. T. Ajai and I. I. Imoko, "Gender differences in mathematics achievement and retention scores: A case of problem-based learning method," *International Journal of Research in Education and Science (IJRES)*, vol. 1, no. 1, pp. 45- 50, 2015.

- [62] C. N. Obi, U. N. V. Agwagah, M. A. Newen and M. N. Nwoye, "Checkmating gender differentials in pupils' achievement and retention in mathematics using origami teaching aid in Nsuka Education Zone," *ABACUS Journal of the Mathematical Association of Nigerian*, vol. 42, no. 1, pp. 422-432, 2017.
- [63] K. O. Usman and M. A. Obidoa, "Effects of Teaching some Geometrical Concept with Origami on Students Achievement. Curriculum and Media Technology Research," *A Journal of CUDIMAC*, vol. 1, no. 1, pp. 190-195, 2017.
- [64] S. O. Olagunju, "Sex, age and performance in mathematics," *ABACUS, Journal of Mathematical Association of Nigeria*, vol. 26, no. 1, pp. 8-16, 2001.
- [65] M. S. Kurumeh and C. O. Iji, "Improving students' Achievement in solving algebraic word problems using aesthetic value approach," *Journal of Mathematical Association of Nigeria*, vol. 34, no. 1, pp. 37-35, 2009.
- [66] P. U. Ekeh, "Gender bias and achievement in science and mathematics among school pupils: Implications for human resource development," *Journal of Curriculum Organisation of Nigeria*, vol. 10, no. 1, pp. 30-33, 2003.