Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education
Print ISSN: 2814-0885 e-ISSN: 2814-0931
www.fnasjournals.com
Volume 5; Issue 3; March 2024; Page No. 62-70.

Effect of Van Hieles' Learning Process on Geometry Performance Among Junior Secondary School Students in Kaduna State, Nigeria

[*1]Aliyu, U.A., & [2]Nwafor, M.C.
[1]Department of Science Education, Kaduna State University[1]
[2]Department of Science Education, Ahmadu Bello University, Zaria-Nigeria[2]

***Corresponding author email*:** umar.aliyu2@gmail.com

Abstract
The study investigates the Effect of Van Hieles' Process of Learning on Performance in Geometry among Junior Secondary School Students in Kaduna State, Nigeria. The study adopted a quasi-experimental research design using the pre-test, post-test and control group design. The population of the study comprised all the junior secondary schools in Kaduna State. A simple Random Sampling Technique was used to select six (6) schools from the three senatorial zones in the state (Kaduna North Senatorial Zone, Kaduna Central Senatorial Zone and Kaduna South Senatorial Zone). The sample of the study consisted of 257 JS II students (168 males and 88 females) from six (6) schools in the state. The instrument used for data collection was the Geometry Assessment Test (GAT) which had a reliability coefficient of 0.75 using Pearson Product Moment Correlation (PPMC). Two research questions and two null hypotheses were formulated and tested for the study. The research questions were answered using mean and standard deviation while the null hypotheses were tested at 0.05 level of significance using Independent Sample t-test statistics. The results of the study revealed that students taught geometry using Van Hieles' process of learning performed significantly better in geometry than those taught the same concepts using the lecture method. Based on the findings of this study, it was recommended that teachers should employ Van Hieles' process of learning in teaching geometry and other aspects of Mathematics at all levels of both junior and senior secondary school.

Keywords: Mathematics, Geometry, Van Hieles' Process of Learning, Gender and Performance.

Introduction

The development of any nation depends on its scientific and technological advancements; and Mathematics is widely recognized as a necessary tool for achieving the development goals of any society, this is because Mathematics is primarily concerned with ideas, processes, and reasoning leading to the solutions of problems. Julius et al. (2018), described Mathematics as a very fundamental subject in the education system of every country in the world. Mathematics is known as one of the gatekeepers to success in all fields of life. Its importance makes it a mandatory subject in Nigeria's education system at both primary (basic) and secondary school levels (Julius et al., 2018). Adeniji and Salman (2016) described it as the backbone of science and technology and a tool that is inevitable for human survival in everyday life. Thus, no science and technology can exist without Mathematics (Ale & Adetula, 2010). Geometry as a branch of Mathematics is concerned with the shape of objects, spatial relationships among various objects, and the properties of surrounding space (Paulina, 2007). It is one of the oldest branches of Mathematics, having arisen in response to such practical problems as those found in surveying. Keith (2017) defined geometry as the branch of Mathematics that exploits visual intuition (the most dominant of our senses) to remember theorems, understand proof, inspire conjecture, perceive reality, and give global insight. Keith, (2017) further asserts that these skills are transferable and are needed in all other branches of Mathematics.

Geometry plays a significant role in primary and secondary school Mathematics curricula in Nigeria and other countries. It provides a rich source of visualization for understanding arithmetical, algebraic, and statistical concepts (Battista, 1999). It is also a major part of the synthetic world such as art, architecture, cars, machines, and virtually everything humans create. In the same vein, studies revealed that geometry is applicable and relevant to employment in everyday life, and other subjects in the curriculum such as science, arts, and technology. Also, geometry is used to develop students' spatial awareness, intuition, visualizations to solve practical problems and so on (Sunzuma et al., 2012).

Despite the critical role played geometry in the education of individuals it has continued to be as a problem area for many students, which becomes a source of bewilderment for students, whereas lecturers of tertiary-level courses continue to complain of students' lack of geometric skills and competences to handle problems. Causes of learning difficulties in Mathematics generally and geometry in particular were reviewed and this has given an insight into the nature and causes and remedies to these challenges. Lack of poor reasoning skills in geometry, geometry language comprehension, lack of visualising abilities, teaching method, poor background knowledge, student knowledge on proofs, gender qualities, and non-availability of instructional materials among others, contribute to the student's perceived difficulty in learning geometry as a Mathematics concept. The Nigerian Educational Research and Development Council (2012) observed that difficult concepts in Mathematics referred to any concept that posed challenges to teachers and learners. Empirical studies on perceived difficult concepts in Mathematics have been addressed by some researchers Uduosoro (2011). Studies revealed that difficulty in teaching and learning geometry has resulted in mass failure in examinations (Nwafor, 2018). Adegun and Adegun (2018) students generally encountered difficulties in geometry and performed poorly in secondary school Mathematics lessons. Telima (2012) found out that many students fail to grasp key concepts in geometry and leave Mathematics classes without learning basic terminology. This study also observes the difficulties encountered by students and proposes remediation by the way geometric concepts are taught to students to improve their understanding of the subject.

A fundamental step for learning the more complex Mathematics that is demanded in science, technology, engineering, and Mathematical (STEM) fields is competency in geometry. Thus, it is not surprising that improving students' learning of geometry is an educational priority; but this learning has proven difficult to achieve for many students. Evidence from the trends of examiner's report, (2012 to 2022) in the performance of candidates in WAEC/SSCE reveals that candidates were generally weak in areas of geometry. This weakness was attributed to among other reasons; poor knowledge of the subject matter, inadequate coverage of the syllabuses and the inability of the candidates to show any firm grasp of the details needed to answer the questions. This situation calls for attention from all those concerned with the teaching of Mathematics education in Nigeria. This disturbing trend in performance in the geometry of students cuts across the gender divide. Literature evidence on gender differences provides that gender issues impact achievement in Mathematics. Hence, it has become germane for educators and researchers to pay attention to gender differences in the design of Mathematics instructions, especially in areas like geometry, which is widely believed to be one area of Mathematics that is crucial for development of the individuals and society in general.

Differences in students' attitudinal variables (anxiety, confidence and motivation), toward Mathematics based on gender were found to show that males had higher mean scores than females (Opolot-Okurut, 2005). This may be an indication that males perform better than females mathematically as a result of their higher attitude scores. The study of Onyeizugbo (2003) highlighted that "sex roles are somewhat rigid in Africa; particularly in Nigeria where gender differences are emphasised." It is commonplace to see gender stereotypes manifested in the day-to-day life of an average Nigerian. Certain vocations and professions have traditionally been regarded as men's (medicine, engineering, architecture), and others as women's (nursing, catering, typing, arts). Abiam and Odok (2016) found no significant relationship between gender and achievement in number and numeration, algebraic processes and statistics. Thus, an attempt to seek a teaching and learning strategy that can improve the academic performance of students in geometry led to the desire to employ Van Hieles' process of learning method. Van Hiele's geometric model of learning defined how students learn to reason in geometry. This model consists of three aspects: the existence of levels, the properties of the levels and the movement from one level to the next higher level (Haviger & Vojkuvkova, 2014). The van Hiele theory comprises two main components: (a) the Level of geometric thinking and its characteristics and (b) the phases of learning (Crowley, 1987). For a student to move from a particular level to the next higher level, he/she has to undergo treatment of some sort, which is facilitated by him/her passing through the learning phases. These learning phases can assist students in learning geometry and, with help from teachers, they will be able to discuss certain concepts and develop a more technical use of language (Serow, 2008). More so, studies have shown that van Hiele theory has greatly improved students learning and performance as well as their levels of thinking in the field of geometry (Alex & Mammen, 2016; Rizki et al., 2018). Thus, this study employs van Hieles' learning process as a treatment for the experimental group of participating students to elicit whether a positive change will be achieved. Therefore, this study investigates the impact of Van Hieles' process of learning on performance in geometry among junior secondary school students, Kaduna State, Nigeria.

Objectives of the Study

The study has the following objectives;

1. Determine the impact of Van Hieles' process of learning on the academic performance of junior secondary school students in geometr**y**.
2. Examine the effect of Van Hieles' process of learning on the academic performance of male and female students in geometry.

Research Questions

This study was guided by the following research questions:

1. What is the difference between the mean academic performance scores of experimental and control groups using Van Hieles' process of learning?
2. What is the difference between the mean academic performance scores of male and female students taught geometry using Van Hieles' process of learning?

Hypotheses

The following research hypotheses were tested at a 0.05 level of significance:

Ho_1: There is no significant difference in the mean academic performance scores of students taught geometry using Van Hieles' process of learning and those taught the same concepts using the lecture method.

Ho_2: There is no significant difference in the mean academic performance scores of male and female students taught geometry using Van Hieles' process of learning.

Methodology

The research design adopted for this study was quasi-experimental, using the pre-test, post-test and control group design. This is because a quasi-experimental design aims to establish a cause-and-effect relationship between an independent and dependent variable. The study used two groups - experimental and control groups. Six (6) randomly selected schools from the three senatorial zones (Kaduna North Senatorial Zone, Kaduna Central Senatorial Zone and Kaduna South Senatorial Zone) of Kaduna state were utilised for the study; two schools per senatorial zone participated. One school was assigned as an experimental group and one as a control group per zone. A pre-test was administered to all groups to ascertain the students' geometry entry level. The test was employed to test for homogeneity. The homogeneity tests consider whether there exists a significant level of variability greater than expected in a sample with variability resulting from random sampling error. The experimental group was taught the selected geometry topics - definitions and properties of plane shapes and perimeter of plane shapes (triangles, rectangles, Squares and parallelograms) for six weeks; using the Van Hieles' process of learning geometry, while the control group was taught same topics using the lecture method as a placebo. The teaching took place simultaneously in all three senatorial zones of the state with support from research assistants. The treatment was administered for six weeks, and a week after the treatments, a post-test was administered to compare and determine the effectiveness of the treatments and the level of students' performance.

The target population for the study specifically comprised all junior secondary school two (JS II) students, in the three senatorial districts of Kaduna State. The choice of JS II was made because this level of JSS is relatively free from external examinations and other activities; as is the case with JS III who are usually engaged with preparation for the Junior Secondary Certificate Examination (JSCE). The three senatorial zones have a total of 45,696 JS II students in the state. Two (2) schools were selected from each of the senatorial zones by purposive sampling technique. This is to allow for the selection of co-educational schools where both male and female students are found. From this, one school was designated as an experimental group and one as a control group. This gave a total of three experimental groups and three control groups. The number of participants for the study was determined by using the intact class in the selected schools. The study therefore utilised a total of two hundred and fifty-seven (257) JS II students; thus, a sample size of 257 participants was arrived at as obtained from the intact classes that participated in the study. The numbers of male and female students were therefore obtained as they were in the various classes utilised.

The instruments used in the collection of data for this study include; the Entry Assessment on Geometry (EAG), and the Geometry Assessment Test (GAT). The EAG and GAT are to provide for entry-level of understanding of participants on geometry concepts and also to assess the actualization of the impact of Van Hieles' process of learning geometry concepts after the treatment respectively. The Entry Assessment on Geometry (EAG) was a pre-treatment assessment test, which was utilized to ascertain the level of understanding of the participants on geometry concepts. The purpose of this instrument in this study was to explore participants' understanding of technical Mathematical concepts as entry-level participants in geometry. The instrument comprised 15 multiple-choice items with 4 options per item per level. The geometric concepts learned in JSI were utilised to determine the level of the participants as they are now in JSII. This includes the geometry concept of shape, analyses of shape, and classifying and defining shape aspects that need to be taught to JS II. The instrument was structured; which means, it requires learners to select only the correct answer out of the 4 possible options given. The questions were also closed; closed questions prescribe the range from which respondents may choose.

The Geometry Assessment Test (GAT) is a post-treatment test which was adapted from the past Junior Secondary School Examination (JSCE) and Mathematics textbooks. The items covered areas of geometry topics taught to the participants (treatment) as contained in the JSII Mathematics curriculum; which comprises the geometric concept of shape, analyses of shape, and classifying and defining shape. The GAT consisted of 25 multiple-choice questions and each question had four (4) options (A – D) in the multiple-choice format. The pre and post-test instruments constructed by the researcher were validated by two experts in the field for face and content validation; in which they examined the adequacy of the topics covered; whether the items tested what it was designed to measure and the suitability of the items for the level of the students; appropriate time scale for the study has to be selected; appropriate methodology has to be chosen, taking into account the characteristics of the study; the most suitable sample method for the study has to be selected. All observations, amendments or recommendations for modification in terms of suitability of the instrument(s) to the level of students were used to modify and improve the instruments. The instruments used for the study were subjected to trial testing as a preliminary assessment. This assisted in determining the feasibility of the study, the usefulness of the instruments used, the appropriate time for the instruments to be administered and the reliability of the instrument.

The sets of tests (GAT) were administered to this group of respondents at the trial testing at a specific time interval of two weeks as proposed by Tuckman (1975). The reliability of the instrument was determined using the split-half method (odd-even). The test used forty (40) students (20 experimental & 20 control) and the scores of each group were split into two halves, arranged as even and odd numbers. The Pearson Product Moment Correlation (PPMC) was used to obtain the reliability coefficient of the instrument of GAT at 0.75. Thus, the instrument was found to be reliable and it was used for data collection in the study. The research questions were subjected to descriptive statistics in the forms of mean and standard deviation like frequencies, percentages of distributions and mean statistics; while null hypotheses were analysed using the inferential statistics of Independent t-test statistics to determine whether the treatment (Van Hieles' process of learning) has an effect on the performance of the experimental group after the treatment.

Results

The data collected in this study were presented in two groups; the experimental group and the control group as presented in Table 1

.

Cite this article as:
Aliyu, U.A., & Nwafor, M.C. (2024). Effect of Van Hiele's learning process on geometry performance among junior secondary school students in Kaduna State, Nigeria. *FNAS Journal of Mathematics and Science Education, 5*(3), 62-70.

Table 1 Distribution of Study Groups

	Frequency	Percent
EG Van Hieles’	147	57.2
CG Lecture Method	110	42.8
Total	**257**	**100.0**

Table 1 shows the distribution of two study groups; the experimental group consisted of 147 students representing 57.2% who are the experimental group taught geometry using the Van Hieles' process of learning and the control group consisted of 110 students representing 42.8% who were taught geometry with the traditional lecture method.

Table 2 Distribution of Male and Female groups

Genders		Male	Female	
Groupings	EG Van Hieles’	87	60	147
	CG Lecture Method	82	28	110
Total		**169**	**88**	**257**

Table 2 shows the distributions of male and female students among the study groups. In the experimental group, 87 of them were males and 60 were females. Among the control group, 82 were males and the rest 28 were females. The analyses of research questions with corresponding null hypotheses were presented using appropriate statistics.

Question One: What is the difference between the mean academic performance scores of experimental and control groups using Van Hieles’ process of learning?

To answer this research question, descriptive statistics of mean academic performance scores, and standard deviations were computed for the experimental group and control group. The finding is presented in Table 3.

Table 3: Summary of Mean and Standard Deviation Students’ Academic Performance Scores in Experimental and Control groups

Study Groups	N	Mean	SD	SE	Mean Difference
Van Hieles’	147	53.46	15.11	1.25	10.87
Control	110	42.60	17.43	1.67	

From the descriptive statistics above there is a positive effect of Van Hieles’ process of learning in the mean score performance of the JSII students taught geometry using Van Hieles’ process of learning. Their computed mean academic performances in geometry are 53.46 and 42.60 by students exposed to Van Hieles process of learning and those exposed to the lecture method of learning respectively. This shows that Van Hieles process of learning geometry is more effective than the conventional method.

H01: There is no significant difference in the mean academic performance scores of students taught geometry using Van Hieles' process of learning and those taught the same concepts using the lecture method.

To test this hypothesis, an Independent samples t-test was used at $p < 0.05$ and the summary of findings is presented in Table 4

Cite this article as:
Aliyu, U.A., & Nwafor, M.C. (2024). Effect of Van Hiele's learning process on geometry performance among junior secondary school students in Kaduna State, Nigeria. *FNAS Journal of Mathematics and Science Education, 5*(3), 62-70.

Table 4: Summary of Independent Sample t-test Statistics on the mean academic Performance score of Experimental and Control Groups

Study Groups	N	Mean	SD	SE	Mean Difference	df	t-cal.	t crit.	p-value
Van Hieles'	147	53.46	15.11	1.25	10.87	255	5.34	1.96	0.00
Control	110	42.60	17.43	1.66					

Calculated p < 0.05, computed t > 1.96 at df 255

The outcome of the independent t-test statistics in Table 4 showed that significant differences exist in the mean academic performance score of the JSII students taught geometry using Van Hieles process of learning and those taught by the traditional lecture method of learning. This is because the calculated p-value of 0.00 is lower than the 0.05 alpha level of significance and the computed t value of 5.34 is higher than the 1.96 t critical at df 255. Their computed mean academic performance scores in geometry are 53.46 and 42.60 by students exposed to Van Hieles stages of learning and those exposed to the lecture method of learning respectively. This shows that Van Hieles process of learning is more effective than the conventional method. Therefore, the null hypothesis which states that there is no significant difference in the mean academic performance scores of students taught geometry using Van Hieles' process of learning and those taught the same concepts using the lecture method, is hereby rejected.

Question Two: What is the difference between the mean academic performance scores of male and female students taught geometry using Van Hieles' process of learning?

To answer this question, mean performance scores and standard deviation of male and female students taught geometry using the Van Hieles' process of learning after treatment were computed, and a summary of the findings was presented in Table 5

Table 5: Summary of Mean and Standard Deviation Statistics on Student Scores for Male and Females in Experimental Group

Variable	Gender of Van Hiele	N	Mean	STD	Std.Err	Mean Difference
Performance scores	Male	87	58.29	14.02	1.50	11.82
	Female	60	46.47	13.93	1.80	

The descriptive statistics in Table 5 showed the impacts of gender on mean academic performance scores of JSII male and female students taught geometry using Van Hieles' processes of learning. Their computed mean performances in geometry are 58.29 and 46.47 by male and female students taught geometry using Van Hieles' processes of learning respectively, with a mean difference of 11.82 in favour of male students. This shows that Van Hieles' process of learning is more effective for male students than for female students.

H02: There is no significant difference in the mean academic performance scores of male and female students taught geometry using Van Hieles' process of learning.

To test this hypothesis, the mean performance scores of students taught geometry using the Van Hieles' process of learning were computed and the mean performance scores between male and female students were compared. Independent samples t-test was used at p < 0.05 and the summary of findings is presented in Table 6.

Cite this article as:
Aliyu, U.A., & Nwafor, M.C. (2024). Effect of Van Hiele's learning process on geometry performance among junior secondary school students in Kaduna State, Nigeria. *FNAS Journal of Mathematics and Science Education, 5*(3), 62-70.

Table 6: Summary of Independent t-test Statistics on the mean academic Performance score of male and female students in the Experiment group

Gender/ Van Hiele	N	Mean	SD	SE	Mean Difference	df	t-cal.	t crit.	p-value
Male	87	58.29	14.02	1.50	11.82	145	5.04	1.96	0.00
Female	60	46.47	13.93	1.80					

Calculated p < 0.05, computed t > 1.96 at df 145

The outcome of the independent t-test statistics in Table 6 showed that a significant difference exists in the mean academic performance score of the JS II male and female students taught geometry using Van Hieles' process of learning. This is because the calculated p-value of 0.00 is lower than the 0.05 alpha level of significance and the computed t value of 5.04 is greater than the 1.96 t critical at df 145. Their computed mean performance scores in geometry are 58.29 and 46.47 by male and female students taught geometry using Van Hieles' processes of learning respectively, with a mean difference of 11.82 in favour of male students. This shows that Van Hieles' process of learning is more effective for male students than female students. Consequently, the null hypothesis which states that there is no significant difference in the mean academic performance scores of male and female students taught geometry using Van Hieles' process of learning is hereby rejected.

Discussion

The result of the finding revealed that the experimental group who were taught geometry using Van Hieles' process of learning performed significantly better than the control group who were taught geometry using the lecture method. This shows that Van Hieles' process of learning is more effective than the lecture method. The findings of the study are consistent with several research works (Erdogan & Durmus, 2009; Khalid & Azeem, 2012; Alex & Mammen, 2016; Armah & Kissi, 2018). In other words, the use of Van Hieles' process of learning has a positive effect on students' performance in geometry. Furthermore, the result agreed with the findings of Usman, Danjuma and Usman (2023) who found out that the Van Hieles' model helps in the cognitive developmental progress of the experimental group which made them perform better than their counterparts in the control group.

The result of the study equally revealed that a significant difference exists in the mean academic performance score of male and female students taught geometry using Van Hieles' process of learning. This is in favour of male students. This shows that Van Hieles' process of learning is more effective for male students than female students. This result confirmed the findings of Kovas et al. (2015) and Musa et al. (2016). This result is contrary to the findings of Usman et al. (2023) who discovered that there was no significant gender difference that exists between male and female undergraduate mathematics students when taught with Van Hieles' model. More so, the result disagrees with the work of Iwendi and Oyedum (2014) who found no gender difference in the performance of male and female students in Mathematics. In addition, the study of Fabiyi, (2017) on the perceived difficulty in learning geometry concepts by senior secondary school students revealed that female students performed significantly more than their male counterparts in geometry lessons. The researcher concluded that students' gender had a great influence on the learning of concepts in geometry.

Conclusion

This study, "Effect of Van Hieles' Process of Learning and Performance in Geometry among Junior Secondary School Students, in Kaduna State, Nigeria reveals some significant results from the treatment of JSS students taught geometry using the Van Hieles' process of learning against those taught geometry using the traditional lecture method. Based on these findings, the study shows that the treatment has some significant impact on JSS geometry students. Further, the study shows that Van Hieles' process of learning is not gender friendly, as the mean performance of female students is lower than that of their male counterparts. Thus, the study concludes that students taught by Van Hieles' process of learning perform better on geometry assessment tests (GAT) than their counterparts who were taught with the conventional lecture method; attesting to the impact of the treatment.

Recommendations

Therefore, based on the outcome of the study, the following recommendations were made;

1. Teachers should employ Van Hieles' process of learning in teaching geometry and other aspects of Mathematics at all levels of both junior and senior secondary schools.
2. The school's authority should encourage teachers to be exposed to the use Van Hieles' process of learning in teaching geometry and Mathematics through organising conferences, seminars, symposiums and in-service training.

References

Abiam, P. O., & Odok, J. K. (2016). Factors in students' achievement in different branches of secondary school mathematics. *Journal of Education and Technology, 1*(1), 161 – 168.

Adegun, I. K., & Adegun, B. O. (2018). Students' and teachers' views of difficult areas in mathematics syllabus: *Basic requirement for curriculum mathematics for JS1-3.* NERDC Press, 62-67.

Adeniji, S. M., & Salman, M. F. (2017). An investigation into the potency of computer-animation in a cooperative setting on senior school students' performance in mathematics. *Nigerian journal of guidance and counselling, 22*(1), 122-133.

Alex, J. K., & Mammen, K. J. (2016). Lessons learnt from employing Van Hiele theory-based instruction in senior secondary school geometry classrooms. *Eurasia Journal of Mathematics, Science & Technology Education, 12*(8), 2223-2236.

Armah, R. B., & Kissi, P. S. (2018). Use of the Van Hiele theory in investigating teaching strategies used by the college of Education geometry tutors. *Eurasia Journal of Mathematics, Science and Technology Education, 2019, 15*(4)

Battista, M. (1999). Geometry results from the third international mathematics and science study. *Teaching Children Mathematics,* 5(6), 367-373.

Crowley, L. M. (1987). The *Van Hiele model of the development of geometric thought. Dalam Learning and Teaching Geometry*, K-12. National of Teachers of Mathematics (NCTM). Reston Virginia: NCTM, Inc.

Fabiyi, T. R. (2017). Geometry concepts in mathematics are perceived difficult to learn by senior secondary school students in Ekiti state, Nigeria. *Journal of Research and Method in Education*, *7*(1), 83-90.

Julius, E., Abdul, H. A., & Nornazira, S. (2018). Attitude of students towards solving problems in algebra: a review of Nigeria secondary schools. *IOSR Journal of Research and Method in Education 8(3)*26-31.

Haviger, J., & Vojkůvková, I. (2014). The Van Hiele levels at Czech secondary schools. *Procedia - Social and Behavioral Sciences 1*(171), 912-918.

Iwendi, B. C., & Oyedum, N. A. (2014). Effects of gender and age on the mathematics achievement of secondary school students in Minna metropolis, Niger state. *Journal of Science, Technology, Mathematics and Education (JOSTMED)*, *9*(1), 161-166.

Keith, J. (2017). Mobility at work; a topology of mobile communities of practice and contexture ambidexterity. *Journal of Strategic Information Systems*, *13*(4), 223-236.

Khalid, A., & Azeem, M. (2012). Constructivist vs traditional: effective instructional approach in teacher education. *International Journal of Humanities and Social Science, 2*(5), 170-177.

Kovas, Y., Garon-Carrier, G., Boivin, M., Petrill, S. A. Plomin, R., Malykh S. B., & Vitaro, F. (2015). Why children differ in motivation to learn: Insights from over 13,000 twins form 6 countries. *Personality and Individual Difference*, 80, 51-63.

Musa, A. K. J., Dauda, B., & Umar, M. A. (2016). Gender difference in achievement goal and performance in English language and mathematics of senior secondary school students in Borno state, Nigeria. *Journal of Educational Practice 7*(27), 165-175.

National Educational Research and Development Council (2012). Religion and national values curriculum for JS1-3. In Federal Ministry of Education 9-year basic education curriculum. NERDC Printing Press, Yaba, Lagos.

Nwafor, M. C. (2018). *Effects of collaborative and scaffolding learning strategies on performance, test anxiety and interest in geometry among secondary school students in Zaria-metropolis, Kaduna state, Nigeria*. An Unpublished PhD thesis, Ahmadu Bello University, Zaria.

Onyeizugbo, E. U. (2003). Effects of gender, age, and education on assertiveness in a Nigerian sample. *Psychology of Women Quarterly, 27*, 12–16.
Opolot-Okurut, C. (2005). Students' attitudes toward mathematics in Uganda secondary schools. *African Journal of Research in Mathematics, Science and Technology Education*, *9*(2), 167-174.
Paulina, M. M. (2007). Perspectives on the teaching of geometry for the 21st century (Dordrecht: Kluwer*)*. *Research Journal*, 3(8), 402-410.
Rizki, H. T. N., Frentika, D., & Wijaya, A. (2018). Exploring students' adaptive reasoning skills and Van Hiele levels of geometric thinking: a case study in geometry. https://doi.org/10.1088/1742-6596/983/1/012148.
Serow, P. (2008). Investigating a phase approach to using technology as a teaching tool. In M. Goos, R. Brown, & K. Makar (Eds.), *Proceedings of the 31st Annual Conference of the Mathematics Education Research Group of Australasia*, (445-452).
Sunzuma, G., Masocha, M., & Zezekwa, N. (2012). Secondary school students' attitudes towards their learning of geometry: A survey of Bindura urban secondary school. *Greener Journal of Educational Research, 3*(8), 402-410.
Telima, A. (2012): Problems of teaching and learning of geometry in secondary schools in River State, Nigeria. *International Journal of Emerging Science*, *1*(2), *143-152.*
Tuckman, B. N. (1975). *Conducting educational research.* Harcourt Brace Jonanorich. Inc.
Uduosoro, U. J. (2011). Perceived and actual learning difficulties of students in secondary school mathematics. *International Multidisciplinary Journal, Ethiopia, 5* (5),357-366.
Usman, H., Danjuma, K. I., & Usman, H. (2023). Effect of Van Hiele model on pedagogical abilities of undergraduate mathematics education students in Niger state, Nigeria. *Journal of Science, Technology and Mathematics Pedagogy, 1*(1), 209-216.
West African Examination Council, (2022). waeconline.org.ng/e-learning/mathematics.