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Exploring Post-Basic Education Students' Preference for Algebra and Geometry Topics in Lagos State

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Abstract
The study examined students' preference of Algebra and Geometry at Post-Basic Education level in Kosofe Local Government Area, Lagos State. Four research questions and two hypotheses were raised to guide the study. Two hundred Post-Basic Education students drawn from two senior secondary schools using simple random sampling technique were used for the study. Students responded to a standardized Algebra and Geometry Topical Inventory which served as instrument for data collection in the study. The instrument was validated by three professionals and yielded a reliability of 0.80 and 0.90 by Cronbach's alpha analysis. Frequency, percentage, mean, standard deviation and independent t-test were used to analyze data. Findings revealed Algebraic fractions and Cosine rule as most preferred topics under Algebra and Geometry respectively while Change of subject of formula and Coordinate geometry, proof of theorems and chord property were observed to be least preferred in these branches of mathematics. Test of hypotheses indicated that male students significantly preferred topics in both Algebra and Geometry than female students. It was therefore recommended that gender responsive pedagogy and text writing at the Post-Basic Education level should be included in Mathematics curriculum. In addition, students' interest, particularly female students, in Algebra and Geometry at Post-Basic Education level should be improved through academic and career talks.
Keywords: Algebra, Geometry, Post-basic education, Gender

Introduction
Mathematics is a subject with far reaching applications and pathway to a number of careers which gave way to its compulsory status at the Basic and Post-Basic Education levels in the Nigerian educational system. Students have expressed

varying levels of interest in the subject owing to a number of reasons including teaching method, gender, attitude, cognitive style and others. Mathematics is subdivided into specific strands at the Post-Basic Education level to aid teaching, assessment and application of concepts as shown in below.

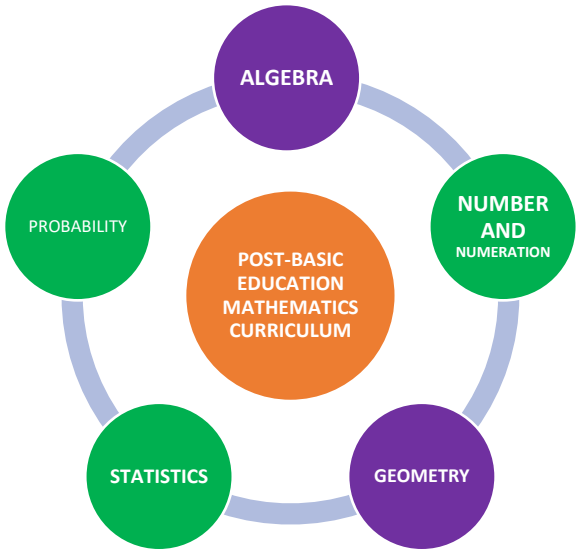

Figure 1: Strands of Mathematics at the Post-Basic Education level

These strands are interrelated at certain points but aid specialization in the subject. The curriculum content however contains a larger number of topics under Algebra and Geometry which explains their weight in terminal assessments such as the Senior Secondary Certificate Examination (SSCE). Algebra is an area in mathematics that uses variables, in the forms of letters and symbols, to act as numbers or quantities in equations and formulas whereas the Geometry strand studies points, lines, 2 and 3-dimensional shapes and objects, surfaces, and solids. Azuka *et al*., (2013) in an empirical study carried out on senior secondary school students found that certain topics in the mathematics curriculum were perceived by students as difficult. The topics include circle geometry, coordinate geometry and bearing which fall under the Geometry strand of mathematics and could deter them from choice disciplines and career aspirations. The spread of questions in the objective section of Senior Secondary Certificate Examination in mathematics

between 2016 and 2020 (Table 1) show that Algebra and Geometry questions account for an average of sixty-two percent (62%) of the assessment questions out of the five strands indicating the weight and importance of these components in the mathematics curriculum.

Table 1: Questions within Algebra and Geometry Strands of Mathematics in SSCE

Year	Total Number of Objective questions	Number of questions under	Percentage (%)	Number of questions under Geometry	Percentage (%)	Total	Percentage (%)
2016	50	11	22	21	42	32	64
2017	50	12	24	20	40	32	64
2018	50	10	20	21	42	31	62
2019	50	22	22	16	32	27	54
2020	50	13	26	20	40	33	66
Mean	**50**	**11.4**	**22.8**	**19.6**	**39.2**	**31**	**62**

Source: WAEC Mathematics Past questions (2016 - 2020)

This makes it imperative to explore students' level of preference for topics within the strands. Apart from this, Algebra is a branch of mathematics whose knowledge is vital for application in other mathematics branches such as Geometry, Trigonometry, and Statistics (Murtala, *et al*., 2022).

Gender has been specified as an important variable in mathematics education hence it is of considerable importance in the investigation of students' preference for Algebra and Geometry topics (Espinoza & Taut, 2020). These demographic variables have been a main determinant to variables in mathematics education and has been researched widely. For instance, the gender gap in mathematics achievement was examined by controlling individual and family background characteristics in Contini *et al*., (2017). The study revealed that average gender gap increased with learners' age and is larger among top performers; as female

achievement was observed to diminish relative to male as they progressed in the educational system. Gender preference for certain aspects of mathematics could be responsible for this as it is capable of affecting students' performance in the subject and further determine placement or selection at higher levels or during career opportunities.

The effect of frequency of testing on students' achievement according to Alade and Kuku (2017) showed that there was no significant difference in mathematics achievement based on gender. Similarly, Lawal and Awofala, (2019) found no statistically significant difference in students' mathematics achievement after the Lesson study intervention. Students' study skills in mathematics along gender as studied by Lawal *et al*., (2020) established that more than one-fifth of their entrepreneurial potential is determined by gender which is an indication of how imperative the gender variable can be in the prediction of students' career potentials. As well, female students appear to show affinity for beauty or art related themes while male students prefer subjects that involve calculation and more abstract parts of the subject. The abstract nature of mathematics seem advantageous to males who are independent minded as opposed to females who are relational or field dependent by cognitive style (Lawal & Awofala, 2019).

Based on the assertions above, gender responsive pedagogy may be needed to enhance students' achievement and interest in mathematics. This will ensure that students do not just offer the subject because of its compulsory nature but for the value it adds to them in the present and future. Paudel's (2020) study found that female students' attendance in mathematics classes is good, but on comparison with male students, their level of success is lower. Hence, while both sexes may possess equal perception ability, lack of encouragement, self-confidence and latent feminine problems may cause the females to lag behind (Contini *et al*., 2024). These are

indications that the gender of students could play a significant role in both mathematics achievement and other measurable aspects or qualities of human life which draws in the need for gender interest in the study.

The way mathematics concepts are presented could also make or mar students' preference in specified areas of the subject. At the primary school level, many teachers were adjudged to lack competence to teach the subject which largely contributes to students' lack of interest translating into poor achievement at higher levels of education (Chand *et al*., 2021). Basic foundations of Algebra and Geometry are laid at this level and when needed competences are lacking, students' interest in these branches of mathematics are hampered due to the hierarchical nature of the subject. Studies abound on the appraisal of students' interest in mathematics and various interventions for its improvement. A number of factors cited in literature are held responsible for students' interest in mathematics which could be linked to their preference for topics in Algebra and Geometry. Corroborating this, Awofala *et al*., (2024) clinched that the teaching and learning of senior secondary schools Science, Technology and Mathematics in Nigeria, is receding; a situation which leads to lack of students' realization of the skills required in the current fourth industrial revolution.

Mamiala *et al*., (2021) utilized a mixed-methods approach to scrutinize high school students' interest in Geometry through qualitative and quantitative data then found that students indicated that teachers continue to teach even when they do not understand. Slightly more than half of students felt unperturbed and relaxed as they attempted Geometry problems whereas three-fifths were confident enough to take Mathematics at high school level, which included Geometry. An empirical study, Adigun (2018) established that factors which could provoke students' interest in Mathematics include parents' encouragement, friends, classmates, career prospects

and job opportunities. A negative influence on students' interest is the perception that the mathematics curriculum is too wide, boring and has no relevance to real life situations (Chand *et al*., 2021). These assertions in literature also provoked studies focused on interventions aimed at enhancement of students' interest in mathematics. Teachers obviously cannot handle all types of students under the traditional chalk and talk method which explains why students continue to lag behind in mathematics achievement and further lose interest in the subject. Enhancement of students' mathematics achievement and interest are therefore major issues particularly with low-achievers. Yeh *et al*., (2019) advocated the learning of mathematics with Math-Island which involves the use of personal tablets at school and home. Murtala *et al*., (2022) considered the effect of the 4MAT instructional model on the interest and achievement of upper basic 3 secondary school students in Algebra. The results showed that teaching using the 4MAT instructional model significantly improved students' achievement and interest in Algebra.

Chow (2011) focused on students' difficulties, conceptions and attitudes towards learning algebra with a background of conceptual change and found that difficulties and misconceptions of students can be classified into basic understanding of letters and their place, manipulation of letters or variables, the use of rules of mathematical manipulation to solve equations, application of the knowledge of algebraic structure and syntax to form equations, and generalisation of rule for repetitive patterns or sequences of shapes. Clearly, it is necessary to address these conceptions.

Assessment of students' topical preferences is a subtle way of appraising their level of interest and listening to their views on mathematical topics which can help to locate the source of low achievement in mathematics in order to ensure solution. The report of Chief Examiners, West Africa Examination Council (WAEC) (2016)

noted the low performance level in Mathematics and called for a review of strategies for teaching and learning Mathematics. These points to the need to explore students' preference for Algebra and Geometry in Mathematics curriculum at the Post-Basic Education level in order to proffer improved strategies for teaching and learning needed to improve the quality of mathematics instruction.

Objective of the Study

The focal objective of the study is to examine senior secondary students' preference for topics in two branches of mathematics. Specifically, the study examined students' self-acknowledged preference for topics within the Algebra and Geometry subdivisions of the subject.

Research Questions

The following research questions were raised to guide the study.

1. What is the pattern of students' preference for Algebra in the Post-Basic Education mathematics curriculum?
2. What is the pattern of students' preference for Geometry in the Post-Basic Education mathematics curriculum?
3. What is students' overall level of preference for Algebra at Post-Basic Education?
4. How can students' overall level of preference for Geometry be described?

Hypotheses

The following hypotheses were stated to guide the course of the study.

$H_0$1: There is no significant difference in students' gender preference for Algebra at Post-Basic Education level

$H_0$2: There is no significant difference in students' gender preference for Geometry at Post-Basic Education level

Methods

The study adopted the descriptive survey research design to gather opinions of senior secondary school students on their preference on Algebra and Geometry at Post-Basic Education in mathematics. The study population comprised all public school senior secondary students within Kosofe Local Government Area of Lagos state. Two hundred (200) Public Senior Secondary Schools 2 and 3 mathematics students made up of 103 males (51.5%) and 97 females (48.5%) were sampled and used for the study. The sample specifically included 71 SS2 and 129 SS3 students representing (35.5%) and (64.5%) respectively. The SS 1 students were not included in the sample because they were not exposed to 50% topics of interest. The range of students' ages lie between 12 and 20 years with a mean of 16.4 years. The simple random sampling technique was employed in the selection of students from two schools using the ballot method. The instrument employed for data collection was a researchers-developed Algebra and Geometry Topics Inventory (AGTI) divided into three parts A, B and C. Part A requested data on students' demographic variables including gender, age and class level. Part B contained the Algebra Topics Inventory while Part C comprised Geometry Topics Inventory. The inventory included all topics under Algebra and Geometry in the senior secondary school Mathematics curriculum.

Each topic on the AGTI was rated on a four-point scale ranging, from Not preferred - 0, Moderately Preferred - 1, Preferred - 2 and Highly Preferred – 3. Cronbach's Alpha coefficients of 0.80 and 0.90 respectively were established for the Algebra and Geometry topic preference. The Algebra inventory contained 11 topics including *Change of subject of formula, Arithmetic Progression and Variation*. Students' scores on this inventory therefore ranged between 1 and 44 with a middle point of 27.5. Similarly, the Geometry inventory contained 16 topics including *Sine and Cosine rule, Plane and Solid Menstruation*. Students' scores on this inventory

lie between 16 and 72 with 44 as the middle point. High points on the inventory depicted students' self-proclaimed preference in Algebra and Geometry. The instrument (AGTI) was subjected to face validity by an expert in measurement and evaluation. For content validity, the instrument was subjected to the scrutiny by two senior secondary school mathematics teachers. The inventory was been found to be a reliable instrument for measurement of students' preference in Algebra and Geometry as its internal consistency reliability coefficient computed using Cronbach alpha (α) gave a value of 0.80 and 0.90 for the Algebra and Geometry topics respectively. These coefficients were generated through a pilot data coded into the SPSS software and subjected to Cronbach's alpha.

The researchers manually administered the AGTI to sampled students during school hours after due permission from the head of the institutions. Data collected were presented and analysed using frequency, percentage, mean, standard deviation and independent t-test.

Result Presentation

Research question one: What is the pattern of students' preference for Algebra in the Post-Basic Education mathematics curriculum?

Table 2 below indicates the level of students' preference for Algebra in the Post-Basic Education mathematics curriculum.

Table 2: Students' Preference for Algebra in the Post-Basic Education Mathematics Curriculum

S/N	TOPICS	Not Preferred (%)	Moderately Preferred (%)	Preferred (%)	Highly Preferred (%)
1.	Linear Equations	34 (17.0)	69 (34.5)	65 (32.5)	32 (16.0)
2.	Linear Inequalities	32 (16.0)	68 (34.0)	68 (34.0)	32 (16.0)
3.	Change of subject of formula.	37 (18.5)	58 (29.0)	67 (33.5)	38 (19.0)
4.	Simultaneous Linear and Quadratic Equations	37 (18.5)	51 (25.5)	64 (32.0)	48 (24.0)

5.	Application of Linear and Quadratic Equations	44 (22.0)	66 (33.0)	58 (29.0)	32 (16.0)
6.	Algebraic Fractions	22 (11.0)	57 (28.5)	70 (35.0)	51 (25.5)
7.	Arithmetic Progression	36 (18.0)	46 (23.0)	72 (36.0)	46 (23.0)
8.	Geometric Progression	48 (24.0)	49 (24.5)	65 (32.5)	38 (19.0)
9.	Variation	48 (24.0)	60 (30.0)	60 (30.0)	32 (16.0)
10.	Logic	79 (39.5)	55 (27.5)	39 (19.5)	27 (13.5)
11	Word Problems leading to equations	44 (22.0)	54 (27.0)	52 (26.0)	50 (25.0)

Analysis of students' preference in Algebra shows that the most preferred topic is Algebraic fractions (51%), followed by Word problems leading to equations (50%), Simultaneous linear and quadratic equations (48%); and Arithmetic Progression (23%). The topic with lowest level of preference were Logic (39.5%); Geometric Progression and Variation (24%); application of linear and quadratic equations in addition to Word problems leading to equations (22%). The distribution of respondents' preference level on the topics show that the highest frequency of preference lie mostly with moderately preferred followed by the preferred, the not preferred, lastly highly preferred. Describing students' level of preference by the highest percentage, linear equations was moderately preferred (34.5%), linear inequalities equations was moderately preferred/preferred (68%), change of subject of formula is preferred (33.5%).

Simultaneous linear and quadratic equation were preferred (33%), while application of linear and quadratic equations was moderately preferred (33%). Similarly, algebraic fractions, Arithmetic Progression, and Geometric Progression were all preferred by 35%, 36% and 32.5% respectively. Variation was both moderately preferred/preferred (30%), logic on the other hand was not preferred while Word problem leading to equations was moderately preferred (27.0%). The students' pattern of preference for Algebra topics is diagrammatically presented in Figure 2 below

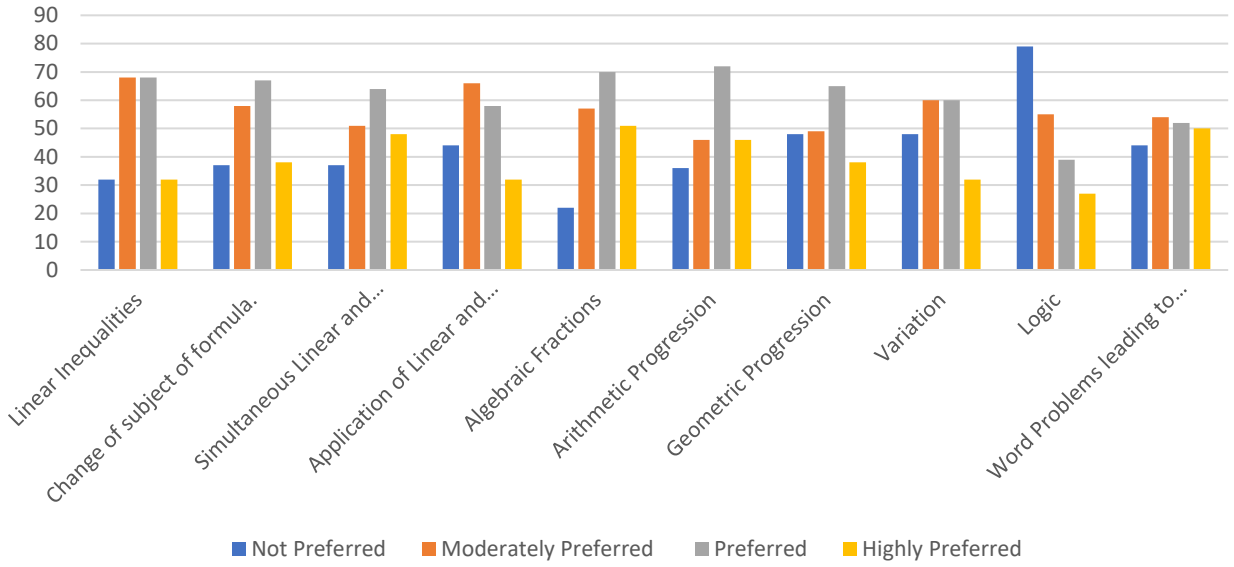

Figure 2: Students' pattern of preference for Algebra Topics

Research question two: What is the pattern of students' preference for Algebra in the Post-Basic Education mathematics curriculum?

Table 3: Students' Preference for Geometry in the Post-Basic Education Mathematics Curriculum

S/N	TOPICS	Not Preferred (%)	Moderately Preferred (%)	Preferred (%)	Highly Preferred (%)
1.	Triangles	32 (16.0)	54 (27.0)	79 (34.5)	35 (17.5)
2.	Sine rule	46 (23.0)	55 (27.5)	64 (32.0)	35 (17.5)
3.	Cosine rule	45 (22.5)	45 (22.5)	69 (34.5)	41 (20.5)
4.	Angles of Elevation and Depression	57 (28.5)	70 (35.0)	45 (22.5)	28 (14.0)
5.	Parallel Lines and Perpendicular lines Angles	83 (41.5)	55 (27.5)	41 (20.5)	21 (10.5)
6.	Bearing and Distances	65 (32.5)	63 (31.5)	38 (19.0)	34 (17.0)
7.	Circle Geometry	77 (38.5)	57 (28.5)	46 (23.0)	20 (10.0)
8.	Graphs of Trigonometry Ratio	86 (43.0)	58 (29.0)	36 (18.0)	20 (10.0)
9.	Longitude and Latitude	94 (47.0)	50 (25.0)	40 (20.0)	16 (8.0)
10.	Chord Property	98 (49.0)	57 (28.5)	25 (12.5)	20 (10.0)
11.	Plane Mensuration	76 (38.0)	64 (32.0)	41 (20.5)	19 (9.50)
12.	Solid Mensuration	93 (46.5)	55 (27.5)	32 (16.0)	20 (10.0)
13.	Constructions and locus	94 (47.0)	42 (21.0)	42 (21.0)	22 (11.0)
14.	Geometrical Ratio	83 (41.5)	45 (22.0)	98 (49.0)	28 (14.0)
15.	Proof of Theorems	98 (49.0)	44 (22.0)	36 (18.0)	22 (11.0)
16	Coordinate Geometry	98 (49.0)	47 (23.5)	36 (18.0)	19 (9.50)

Table 3 shows students' preference Geometry in the Post-Basic Education Mathematics Curriculum. The mean preference in descending order shows that most students do not prefer topics in geometry, followed by 26.9% those who prefer Geometry topics moderately, 23.9% preference and 12.4% preference. A look at the topics and analysis of students' preference for shows that the frequency of students' dislike for geometry topics in descending order can be summarized thus: Coordinate geometry, Proofs of theorem and Chord property (49%); Construction and Locus; Longitude and Latitude (47%); Solid mensuration (46.5%); Geometry Ratio (43.0%); Circle Geometry (38.5%); Plane mensuration (38%); Trigonometry, Bearings and Distances (32.5%); and Angle of Elevation and Depression (28.5%). The most preferred topics were Cosine rule, Triangles and Sine rule (17.5%). Students' pattern of preference for Geometry is presented diagrammatically in Figure 3.

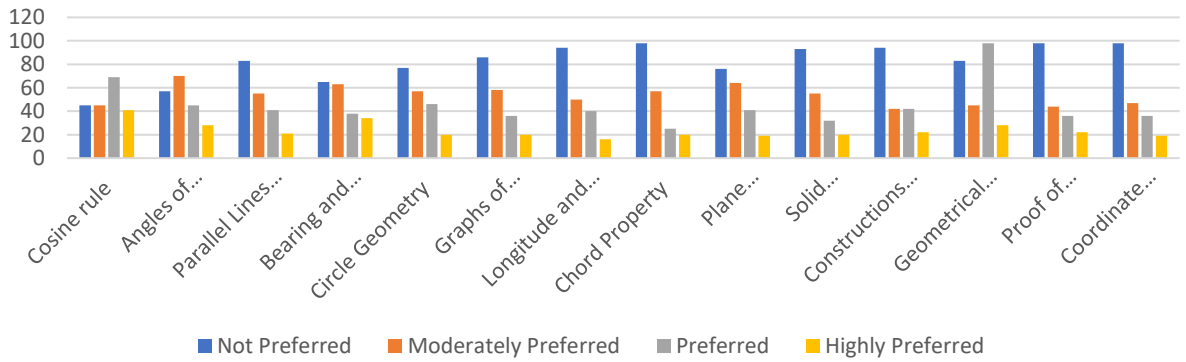

Figure 3: Students' Pattern of Preference for Geometry

Research question three: What is the overall level of preference for Algebra?

Table 4: Post-Basic Education Students' Overall Level of Preference for Algebra

GENDER	ALGEBRA
Mean	27.63
N	200
Std. Deviation	6.660
Minimum	12
Maximum	44
Midpoint	27.50

Table 4 shows that the mean preference of students for Algebra topics was 27.63 out of a maximum of 44. This is slightly above the middle point mark of 27.5 points and scarcely above average. The minimum score on the Algebra topics preference inventory was 12 points which is only one point above the obtainable minimum of all points on the Algebra Topic Preference Table showing that certain students do not prefer all the topics thereby earning minimal points for all the topics except one.

Research question four: How can students' overall level of preference for Geometry be described?

Table 5: Students' Overall Level of Preference for Geometry

GENDER	GEOMETRY
Mean	37.94
N	200
Std. Deviation	11.383
Minimum	18
Maximum	72
Midpoint	44

The overall preference level of students for Geometry topics was derived as 37.94 out of the maximum 72 points. The middle point being 45 indicates a low middle point mean value showing lack of preference for topics in Geometry. The minimum score of 18 points tallies with the lowest possible point obtainable, showing that some students consistently lacked preference for all the topics under Geometry.

Test of Hypotheses

$H_0$1: There is no significant difference in students' gender preference for Algebra at Post-Basic Education level

Table 6: Independent t-test Statistics of Algebra topics preference by Gender

GENDER	N	Mean	Std. Deviation	T	Df	Sig	Remark
MALE	103	29.61	6.553	3.938	199	0.000	Significant
FEMALE	97	25.63	6.164				

Table 6 shows that male students had a higher preference for topics in Algebra (m = 29.61. sd = 6.553) than female students (m = 25.63, sd = 6.164). The t-test statistics revealed that the difference observed in their topical preference under Algebra was statistically significant ($p < 0.05$) the null hypothesis is therefore rejected and conclude that male students significantly prefer topics in Algebra than female students.

$H_0$2: There is no significant difference in students' gender preference for Geometry at Post-Basic Education level

Table 7: Independent t-test Statistics of Geometry topics preference by Gender

GENDER	N	Mean	Std. Deviation	T	Df	Sig	Remark
MALE	103	39.52	11.846	2.012	199	0.046	Significant
FEMALE	97	36.00	10.672				

Table 7 indicates that male students displayed a higher preference for topics in Geometry (m = 39.52, sd = 11.846) than their female counterparts (m = 36.00, sd = 10.672). Inferential independent t-test statistics in Table 7 reveals that the difference in mean is statistically significant with $p = 0.046 < 0.05$. The null hypothesis is therefore rejected and conclude that there is a significant difference in topical preference for Geometry topics according to students' gender.

Discussion of Findings

The spread of students' preference for topics in Algebra affirmed great fondness for algebraic fractions, word problems leading to equations and simultaneous linear and quadratic equations. In Geometry, students indicated much penchant for Cosine rule, Sine rule and Triangles while Coordinate geometry, Proofs of theorem and Chord property were greatly disliked. This established the results of Azuka *et al*., (2013) who found that students perceived these Coordinate geometry and circle theorems as difficult topics. The consonance of the Azuka *et al*., (2013) result with this study despite the year interval between them shows that post basic education students are continually faced with issues on these topics. A strong concern about topic preferences is that it happens at the expense of other topics such that less preferred ones create a drawback on students' achievement in the entire

subject as grades are not allotted to strands but cumulated during mathematics assessments.

Students' mean preference for topics in Algebra lies around the midpoint, showing a relatively mild preference and interest for Algebra topics. Chow (2011) corroborates this result by unveiling students' inability to apply mathematical rules in the solution of equations alongside misconceptions on letters and algebraic structure. The mean preference for Geometry topics on the other hand was below midpoint indicating poor preference for the themes under this strand. The reason for this may not be far-fetched as students perceive mathematical concepts as uninteresting and too numerous (Chand *et al*., 2021). Unfortunately, the Geometry strand, out of the five strands of post-basic mathematics curriculum, covers almost two-fifths of the objective assessment in SSCE mathematics (Table 1) and has great application in engineering, architecture and other career areas.

Outcomes of inferential statistics in the study showed that male students significantly prefer both Algebra and Geometry topics than female students. This finding verifies reports by Adeleke (2008) and Contini *et al*., (2017) who found significant gap in gender achievement as students attained higher academic levels. This may also not be unconnected with the manner in which mathematical concepts are presented at higher educational levels which lack direct application to real life situations and does not showcase the true beauty of the concepts (Chand *et al*., 2021). The finding also buttresses Paudel (2020) that while male and female students are exposed to same resources, certain female inherent features may cause them to lag behind. Nonetheless, other researches such as Lawal and Awofala, (2019); Alade and Kuku, (2017) as well as Ajai and Imoko, (2015) emphasized that the mathematics achievement gap with respect to gender is waning, claiming that male and female students are at par in terms of mathematics achievement. Caution needs be taken however to ensure that the significant difference observed in students' gender preference for mathematical topics does not eventually widen the achievement gap in mathematics.

Conclusion

The study concluded based on the findings that under Algebra, students' most preferred topic is Algebraic fraction whereas the least preferred was Change of subject of formula. Similarly, students rated Cosine rule, Triangles and Sine rule as most preferred while Coordinate geometry, Proofs of theorem and Chord property were the least preferred themes under Geometry. Overall, students mean preference for Algebra topics was just about the midpoint while the mean preference was below midpoint for Geometry topics. Male students significantly prefer both Algebra and Geometry topics than female students.

Recommendations

Recommendations from the results of this study are highlighted as follows:

1. Students' interest, particularly female, in Algebra and Geometry at the Post-Basic Education level should be encouraged by various educational stakeholders (parents, teachers and school administrators) through academic and career talks on the emphasis and importance of these branches of mathematics for future academic and career opportunities.
2. Gender responsive pedagogy and text writing should be curriculum-guided and monitored to improve female students' preference in Algebra and Geometry branches of mathematics.
3. More interactive and exciting instructional materials such as the Geogebra software and other modern instructional applications should be adopted for teaching and presentation of Geometry as students' average preference level for this branch of mathematics fell below the midpoint.
4. A study on the preference of upper basic students in mathematical topics is recommended as a follow up to this study in order to unravel probable background preferences which leading to the ones observed.

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