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INFLUENCE OF ACADEMIC ABILITY LEVELS ON SENIOR SCHOOL STUDENTS' CONCEPTIONS OF GEOMETRY IN OGUN STATE, NIGERIA

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Abstract

This study examined the influence of academic ability levels on senior school students' conceptions of Geometry. The study was a descriptive type using the survey method carried out in Ogun State, Nigeria. Four research questions and one hypothesis guided the study. The population for the study was all SSS2 students in Ogun State. A sample of 757 SSS2 students selected through stratified and proportionate sampling technique from 56 senior secondary schools participated in the study. Collection of data was done using a 26-item Geometry Conception Test (GCT) validated by 8 experienced Mathematics educators. A test-retest reliability index of 0.83 was gotten using Pearson Product Moment Correlation statistics. The study employed frequency counts, percentages and Chi-square statistics to analyze the data generated from the study. The findings revealed that students holding misconceptions and alternative conceptions of geometry were more than students with correct conceptions of the selected concepts in geometry. Also, students' academic ability levels had no significant influence on their conceptions of geometry. It was recommended that the low academic ability levels and medium academic ability level students should be encouraged to solve more exercises using mathematics dictionary to enhance their understanding and to minimize misconceptions and alternative conceptions of concepts in geometry. High academic ability level students should also be encouraged to avoid overconfidence which could lead to misconceptions and alternative conceptions of geometry.

Key words: Conceptions; Secondary school geometry; Students' academic ability

Introduction

Geometry is a branch of Mathematics which plays vital roles in many fields of human endeavours. It is one of the major themes in the Mathematics curriculum at the senior school levels due to its roles in the development of students' logical reasoning and perpetual abilities crucial in the learning of other aspects of Mathematics and other school disciplines (Sambo, 2015). The knowledge of geometry is applicable to day-to-day activities such as in measurement of length and height, description and estimation of distance as well as approximating the exactness of phenomena to mention a few. The relevance of geometry in Science, Technology, Engineering, Architecture and other related disciplines where its knowledge and applications are needed for human and societal development especially in the development and sustainability of a nation.

Regardless of the vital roles of geometry in individuals and societal developments, there have been unsatisfactory remarks concerning students' attempts of geometry questions in standardize examinations such as the West African Senior School Certificate Examinations (WASSCE). According to the West African Examinations Council's Chief Examiners' Report May/June (2007, 2008, 2009, 2010, 2011, 2012 and 2013), questions on geometry were arbitrarily attempted by candidates. Also, Musa and Bolaji (2015) further observed that few students who attempted questions on geometry displayed weakness in answering them while others avoided geometry questions.

One of the concerns of Mathematics teachers and researchers is how to improve students' performance as well as to discover reasons for students' poor performance in Mathematics examinations. The consistent unsatisfactory low performance in geometry questions during Mathematics examinations has been linked to many factors. Prominent among them is lack of understanding of the concept of geometry due to students' conceptions about geometry (Atebe, 2008; Arleback, 2009). Conception is a body of beliefs held by an individual in explaining certain events. It is a stage which a learner reaches in order to obtain meaningful learning. This involves the learner's understanding of the concepts or ideas of that particular field of study based on his or her previous knowledge. However, these views on conception established constructivism submission that every individual builds up his or her knowledge from past experiences (Novak, 2003).

Everyone is a carrier of one idea or the other. The prior ideas brought into the classroom by students can either be said to be correct conceptions, misconceptions or alternative conceptions depending on individual's previous experience(s) regarding the related phenomenon. Correct conceptions are ideas held by individuals that agree with accepted scientific ideas or knowledge. Misconceptions are wrong ideas, beliefs that are not based on correct information, nor understood by people (Hornby, 2010). They are described as errors, mistakes misleading ideas, misunderstandings or misinterpretation of facts that needed to be corrected. Alternative conception is a term used for describing the idiosyncratic knowledge. This knowledge is not necessarily in conflict with accepted scientific knowledge but has its own value and is not necessarily wrong (Hewson, 2007). An alternative conception is used to describe learner's autonomous conceptions of natural phenomena, which is neither wrong nor right but expresses learner's views about the concept (Balogun, 2010; Abdulraheem, 2012; Abimbola, 2013).

This scenario is equally applicable to Mathematics students especially during geometry lessons. Students' experiences regarding geometry before coming to the class for geometry lessons are the prior ideas responsible for their views and conceptions about geometry (Novak, 2003; Hewson, 2007). In a bid to find out reasons and causes of students' weaknesses and avoidance of geometry questions, the researcher carried out a survey to investigate the conceptions of senior school students on selected concepts in geometry in relation to the influence of academic ability levels on their conceptions of geometry.

The ideas of learning theories gave insight into how meaningful instruction can be achieved irrespective of students' conceptions about learning. These include hierarchical processes of learning from simple concepts to complex ones which is synonymous to learning from known to unknown. This is easily achievable when the memory contains the presence of related skills to the knowledge to be acquired which are in line with the learners' level or stage of development (Gagne,1965; Ausubel,1968).

Mathematics experiences students had before coming to the classroom could be investigated into. This is necessary in order to discover students' views about geometry as well as working out the corrections needed for any trace of misconception or alternative conception about geometry. Taking this step could check against influences these incorrect conceptions might have on their conceptions about geometry and minimizes interferences with acceptable scientific knowledge of geometry (Houston, 2001; Burton, 2004). This also indicates that people have different ideas about learning based on the importance attached to it, which could be categorized as a necessity or compulsion in the learning process. These various outlooks to learning lead to the idea that learning is a multidimensional phenomenon which allows students to hold different conceptions of learning (Ayodele, 2011).

Alamdarloo, Moradi and Dehshiri (2013) researched on the relationship between students' conceptions of learning and their academic achievement in Tehran City, Iran. A sample of 309 students selected through multistage cluster sampling technique participated in the study. Purdie and Hattie's (2002) questionnaire was used to generate the data for the study and to measure their academic achievement. The results showed that a significant relationship existed between students' conceptions of learning and their academic achievement. Also a meaningful relationship existed between students' number of conceptions of learning and their academic achievement.

Inyang and Ekpeyong (2000) showed that, all the children who came to school possess the ability to learn but some are slow at learning than others. This report was given in a study on the influence of ability and gender groupings on senior secondary school chemistry students on the concept of Redox Reactions. The study reported that, students were grouped as high, average and low academic ability levels with separate gender groups respectively. The findings from the study showed that, there is a significant difference between the mean post-test and pre-test scores among students of different academic ability levels in the understanding of the concept of Redox Reactions. Some of the students involved in the study attributed their performance to their ability while some of them attributed theirs' to the difficulty of the task at hand, which could be as a result of misconceptions and alternative conceptions exhibited by them.

A related study was conducted by Balogun (2010) on conception of thermodynamics held by colleges of education Chemistry students in Kwara State. A test consisting of 10-item Thermodynamic Conception Test (TCT) was administered on final year Chemistry students grouped into high, medium and low ability groups. Report of the findings showed that low ability students had the greatest percentages of misconceptions of thermodynamics followed by medium ability students, while the high ability students had the lowest percentages of misconceptions of thermodynamics. The report showed that academic ability level had no influence on students' conceptions of thermodynamics.

Similarly, Abdulraheem (2012) studied the conception of electromagnetism held by colleges of education Physics students in North Central State, Nigeria. The instrument used for the study was 20-item Electromagnetic Conception Test (ECT). The participants of the study were all the final year NCE Physics students grouped into different ability groups as high, medium and low ability groupings. The findings of this study revealed that the medium ability group had the highest percentage of correct conceptions of Electromagnetism, followed by the high ability group. The low ability group had the least percentage of correct conception of the concept of Electromagnetism.

Supporting this assertion, Purdie and Hattie (2002) reported that when students' conceptions of learning are high in the hierarchy, they have better learning and greater academic achievement. Also, a relationship exists between the depth of students' conceptions of learning and their academic achievement, such that the deeper the students' conceptions of learning, the higher these conceptions are in the hierarchy and the better their academic achievement. In this regard, it can be concluded that students' conceptions of learning can predict their academic achievement (Fisher, 2008).

Statement of the Problem

The concern of every stakeholder in Mathematics education is on students' performance. Unsatisfactory reports about students' performance in Mathematics examinations necessitate a need to look into likely reasons and causes for such dismal performance. One of the topics in Mathematics where students' performance has created concerns for Mathematics educators is geometry. Reports showed that questions on geometry were not satisfactorily attempted by the few candidates who attempted them while some candidates avoided geometry questions.

Lack of understanding of geometrical concepts is one of the major factors identified for poor performance as well as avoidance of geometry questions during Mathematics examinations. Previous incorrect ideas held by the students which could either be misconceptions or alternative conceptions resulting from previous ideas students had before their classroom experiences were found to be responsible for the misunderstandings encountered by students in learning (Hewson, 2007; Novak, 2003). Houston (2001) and Burton (2004) researches in Mathematics upheld that finding out students' views of learning Mathematics could provide a justification for investigating Mathematicians' as well as students' views of the discipline. Thus, identifying these incorrect conceptions can be the basis for finding ways of correcting them.

Students' previous experiences as well as their ability levels are found to contribute to their performance as well as their conceptions in learning (Ausubel, 1968). Gagne (1965) theory of learning emphasized that, learning takes place when certain relevant skills are present in the memory before the acquisition of current experience(s). Likewise, students' classroom expressions could be categorized as correct conceptions, misconceptions or alternative conceptions based on students' views about the topic. It is on this path that this research was conducted to identify what is incorrect about students' conceptions of geometry using selected concepts to sieve their views. By defining these concepts, students exhibited their conceptions whether it was correct or incorrect based on the definitions given, or the concepts were misunderstood. This study therefore investigated the influence of academic ability levels on students' conceptions of geometry.

Purpose of the Study

Specifically, this study identified:

- the number of senior school students with correct conceptions, misconceptions and with alternative conceptions of geometry;
- the number of senior school students with correct conceptions of geometry based on academic ability levels.
- the number of senior school students levels with misconceptions of geometry based on academic ability levels.
- the number of senior school students with alternative conceptions of geometry based on academic ability levels.

Research Questions

1. What proportions of senior secondary school students are holding correct conceptions, misconceptions and alternative conceptions of geometry?
2. Is there any difference in the number of senior school students holding correct conceptions of geometry based on academic ability level?
3. Is there any difference in the number of senior school students holding misconceptions of geometry based on academic ability level?
4. Is there any difference in the number of senior school students holding alternative conceptions of geometry based on academic ability level?

Research Hypothesis

H0: There is no significant difference in the number of senior secondary school students holding correct conceptions, misconceptions and alternative conceptions of geometry based on academic ability level.

Methodology

The study is a descriptive one using the survey method to gather information. The population for this study was all students in senior secondary school II in Ogun State, Nigeria. The sample for the study comprised of seven hundred and fifty seven (757) senior school students comprising of four hundred and forty three (443) students from public senior secondary schools and three hundred and fourteen (314) students from private senior secondary schools. Proportionate and stratified sampling techniques were used for the selections to ensure that, proportional representations of each stratum were randomly obtained from each local government areas of Ogun State. The instrument for this study was researcher-designed Geometry Conception Test (GCT) which consisted two parts. Part 1 consisted of demographic data of respondents while Part 2 consisted of 26-items on conceptions of geometry and a researcher made coding scale. The respondents were requested to explain fully what they understood about each of the concepts and sub-concepts of geometry contained in the Geometry Conception Test (GCT). The students were asked to explain fully the meaning of each of the geometrical concepts and sub-concepts in Mathematics as understood by them and illustrate with diagrams as appropriate in the spaces provided in the test sheet. These are: a plane; a triangle; a circle; the circumference of a circle; a diameter of a circle; a radius of a circle; the sector of a circle; the segment of a circle; the chord of a circle; a secant of a circle; a tangent to a circle; a quadrilateral; a quadrilateral with equal sides and equal angle; a polygon; the sum of exterior angle of a polygon; the area of a plane shape; the perimeter of a plane shape; an angle; a vertex; a solid shape / figure; a cube; a cuboid; an edge of a shape; an irregular shape; a good example of an irregular shape; and the difference between a regular shape and an irregular shape.

A result format was also used as a supporting instrument given to the teachers or examinations officers of each participating schools to fill in order to get the participating students' terminal results. Information collected on the result format enabled the researcher to classify the respondents into high, medium and low academic ability levels. High academic ability students are students that scored 60% and above in terminal examinations, medium academic ability students are students with 40% to 59% scores in terminal examinations, while low academic ability students are students with 39% scores and below in terminal examinations.

The validation of the instrument was done by three experts in the Department of Science Education, three Mathematics experts in the Department of Mathematics, University of Ilorin and two experienced secondary school Mathematics teachers in Ogun state. The reliability of the instrument was tested using test-retest. A reliability index of 0.83 was obtained from the exercise using Pearson Product Moment Correlation Coefficient formula.

The researcher with the co-operations of research assistants visited the selected schools and administered the questionnaire to enhance their prompt responses. The study lasted a period of twelve (12) weeks. Data collected was subjected to both qualitative and quantitative analyses. Qualitatively, the responses were analyzed to identify the nature of conceptions whether correct conceptions, misconceptions, or alternative conceptions. The identified misconceptions and alternative conceptions were validated by four raters which conclusions were based on the agreement of the four raters. Quantitatively, the data was subjected to statistical analysis and interpretations. Frequency counts and percentages were used to answer the research questions. However, Chi-square analysis was used to test the hypothesis formulated for the study at 0.05 level of significance.

Results and Discussion

The results of the study are presented in the Tables 1 to 4.

Research Question 1: What proportions of senior secondary school students are holding correct conceptions, misconceptions and alternative conceptions of geometry?

Table 1 shows that, students with correct conceptions of geometry had higher percentages of 50% and above respondents with correct conceptions in only 5 items of the Geometry Conception Test, which are: triangle; diameter of a circle; radius of a circle; chord of a circle; and a quadrilateral out of the 26 items contained in the Geometry Conception Test. The remaining 21 items had less than 50% respondents with correct conceptions. However, students with misconceptions had higher frequency counts and percentages of 50% and above respondents holding misconceptions in 17 items out of the 26 items contained in the Geometry Conception Test. Also, students displayed alternative conceptions in all the 26 items of the Geometry Conception Test.

Table 1:

Frequency Counts and Percentages of Senior School Students Holding Correct Conceptions, Misconceptions and Alternative Conceptions of Geometry

Concept	N0. of Students with Correct Conceptions	N0. of Students with Misconceptions	N0. of Students with Alternative Conceptions
1. A plane	97 (12.81%)	428 (56.54%)	232 (30.65%)
2. A triangle	468(61.82%)	105 (13.87%)	184(24.31%)
3. A circle	204(26.95%)	236(31.18%)	317(41.88%)
4. Circumference of a circle	269(35.54%)	312(41.22%)	176(23.25%)
5. Diameter of a circle	455(60.11%)	156(20.61%)	146(19.29%)
6. Radius of a circle	473(62.48%)	152(20.08%)	132(17.44%)
7. Sector of a circle	336(44.39%)	294(38.84%)	127(16.78%)
8. Segment of a circle	126(16.68%)	465(61.43%)	166(21.93%)
9. Chord of a circle	420(55.48%)	212(28.01%)	125(16.51%)
10. A secant of a circle	34(4.49%)	672(88.77%)	51(6.74%)
11. A tangent to a circle	223(29.46%)	391(51.65%)	143(18.89%)
12. A quadrilateral	397(52.44%)	240(31.70%)	120(15.85%)
13. A quadrilateral with equal sides and equal angles	336(44.39%)	391(51.65%)	30(3.96%)
14. A polygon	254(33.55%)	407(53.76%)	96(12.68%)
15. The sum of the exterior angles of a polygon	290(38.31%)	432(57.07%)	35(4.62%)
16. The area of a plane shape	29(3.83%)	571(75.43%)	157(20.74%)
17. The perimeter of a plane shape	85(11.23%)	535(70.67%)	137(18.10%)
18. An angle	148(19.55%)	397(52.44%)	212(28.01%)
19. A vertex	163(21.53%)	529(69.88%)	65(8.59%)
20. A solid shape/figure	108(14.27%)	542(71.60%)	107(14.13%)
21. A cube	218(28.80%)	378(49.93%)	161(21.27%)
22. A cuboid	136(17.97%)	469(61.96%)	152(20.08%)
23. An edge	63(8.32%)	633(83.62%)	61(8.06%)
24. An irregular shape	81(10.70%)	557(73.58%)	119(15.72%)
25. Examples of irregular shapes	116(15.32%)	598(79.00%)	43(5.68%)
26. Difference between a regular shape and irregular shape	68(8.98%)	568(75.03%)	121(15.98%)

N = 757

The proportions of students with misconceptions and alternative conceptions were more than the proportion of students with correct conceptions. The result further indicated that the proportion of students with misconceptions was more than the proportion of students with alternative conceptions. This result may be traced to the fact that, students lack the understanding of some basic concepts in geometry.

The inference was in line with the findings of Aysen (2012) who researched on misconceptions in geometry in Nicosia, Cyprus involving seventh-grade students. The results from this study revealed that 7th-grade secondary school students held a number of misconceptions and they lacked background knowledge, reasoning and basic ideas of the concepts and sub-concepts of geometry. In addition, students' misconceptions in geometry may be traced to factors such as using inappropriate vocabularies or the alternatives to describe relevant geometrical statements and their relationships. Also, teachers' insufficient explanations of definitions and illustrations of those concepts could generate misconceptions and alternative conceptions of geometry in students.

Furthermore, findings from the present study corroborated those of Arleback (2009) and Atebe (2008) with regard to lack of understanding of Mathematics. It was also in line with the findings of Abdulraheem (2012) in Physics and Balogun (2010) in Chemistry. The researchers cited above pointed to the fact that students had poor performance as a result of misconceptions held by students and their lack of understandings of these subjects. Students' poor performance indicated in these findings could be caused by their lack of background knowledge, reasoning and mistakes in basic operations of the topic (Aysen, 2012).

Burton (2004) pointed out that, students' views, understanding and poor background about Mathematics could also lead to misconceptions and alternative conceptions resulting to poor performance in Mathematics. Also, teachers' inability to finish the syllabus, as well as the use of inappropriate teaching strategies in Mathematics lessons could also lead to misconceptions and alternative conceptions.

Results from these studies showed that misconceptions and alternative conceptions of various concepts of Mathematics and Sciences exist among students before and after instructions. This implies that students prior knowledge brought into the classroom can either be displayed as correct conceptions, misconceptions or alternative conceptions. Some of these misconceptions and alternative conceptions could have persisted after classroom experiences. The existence of misconceptions and alternative conceptions could hamper meaningful learning. It is however the responsibility of the Mathematics teachers to ensure that students are properly guided in the acquisition of the correct conceptions of geometry (Hewson, 2007).
Findings from this study can be viewed from another perspective as Clement (2001) noted that, not all prior ideas brought to the classroom are misconceptions. Also, not all mistaken students' expressions indicate the presence of alternative conceptions. In order for students to understand the scientific knowledge and models presented to them, it is necessary for students to re-structure their ideas to learn meaningfully by confronting their prior knowledge or previous ideas whether they are misconceptions or alternative conceptions (Aysen, 2012).
Research Question 2: Is there any difference in the number of senior school students holding correct conceptions of geometry based on academic ability level?

The focus on the number of senior secondary school students holding correct conceptions of geometry based on academic ability levels, differences existed in the number of students holding correct conceptions of geometry in Ogun State, Nigeria based on their academic ability levels.

High academic ability level students had the highest percentage of students holding correct conceptions of geometry in 22 items of the Geometry Conception Test. This was followed by medium academic ability level students in 4 items, while low academic ability level students had the least number of respondents with correct conceptions of geometry. Table 2 reveals this result.

Table 2

Frequency Counts and Percentages of Senior Secondary School Students Holding Correct Conceptions of Geometry based on Academic Ability Levels in Ogun State, Nigeria

Concept	**N0. of Students Holding Correct Conception of Geometry Based on Academic Ability Levels**					
	Frequency of **High Ability Levels**	Percentage (%)	Frequency of **Medium Ability Levels**	Percentage (%)	Frequency of **Low Ability Levels**	Percentage (%)
1. A plane	31	18.56	55	12.04	11	8.27
2. A triangle	125	74.85	277	60.61	66	49.62
3. A circle	46	27.54	125	27.35	33	24.81
4. Circumference of a circle	85	50.90	151	33.04	33	24.81
5. Diameter of a circle	113	67.66	283	61.93	59	44.36
6. Radius of a circle	117	70.06	293	64.11	63	47.37
7. Sector of a circle	84	50.30	201	43.98	51	38.36
8. Segment of a circle	36	21.56	74	16.19	16	12.03
9. Chord of a circle	92	55.09	272	59.52	56	42.10
10. A secant of a circle	7	4.19	26	5.69	1	0.75
11. A tangent to a circle	62	37.13	138	3.20	23	17.29
12. A quadrilateral	107	64.07	241	52.73	49	36.84
13. A quadrilateral with equal sides and equal angles	91	54.49	197	43.11	48	36.09
14. A polygon	65	38.92	161	35.23	28	21.05
15.Sum of exterior angles of a polygon	64	38.32	181	39.61	45	33.83
16.Area of a plane shape	11	6.59	15	3.28	3	2.26
17. Perimeter of a plane shape	30	17.96	48	10.50	7	5.26
18. An angle	39	23.35	95	20.79	14	10.53
19. A vertex	48	28.74	94	20.57	21	15.79
20. A solid shape	37	22.16	57	12.47	14	10.52
21. A cube	64	38.32	131	28.66	23	17.29
22. A cuboid	40	23.95	80	17.50	16	12.03
23. An edge of a shape	25	14.97	35	7.66	3	2.26
24. An irregular shape	28	16.97	40	8.75	13	9.77
25. A good example of an irregular shape	41	24.55	59	12.91	16	12.03
26. The difference between a regular shape and an irregular shape	24	14.37	34	7.44	10	7.52

Research Question 3: Is there any difference in the number of senior school students holding misconceptions of geometry based on academic ability level?

The focus on the number of senior secondary school students holding misconceptions of geometry based on academic ability levels (high, medium and low), low academic ability levels students had the highest frequency counts and percentages of respondents holding misconceptions of geometry. This was followed by medium academic ability levels students, while high academic ability level students had the least frequency counts and percentages of respondents holding misconceptions of Geometry in Ogun State, Nigeria.
The responses of the students to the Geometry Conception Test with low academic ability level students having higher percentages of respondents with misconceptions than the high and the medium academic ability levels students indicated that, the low academic ability level students were deficient in geometry. Also, the low and the medium academic ability level students could have high scores in Mathematics if their misconceptions in geometry are taken care of. This could eventually add to their overall performance in Mathematics. Table 3 reveals this result.

NOTE: In Table 3: H= Frequency of High Academic Ability Level Students; M= Frequency of Medium Academic Ability Level Students; L= Frequency of Low Academic Ability Level Students.

Table 3
Frequency Counts and Percentages of Senior Secondary School Students Holding Misconceptions and Alternative Conceptions of Geometry based on Academic Ability Levels in Ogun State Nigeria

Concept	Frequency and percentage (%) of High, Medium and Low Academic Ability Level Students											
	MISCONCEPTIONS						ALTERNATIVE CONCEPTIONS					
	H	%	M	%	L	%	H	%	M	%	L	%
1. A plane												
2.A triangle	89	53.29	260	56.89	79	59.40	47	28.14	142	31.07	43	32.33
3A circle	10	5.99	66	14.44	29	21.80	32	19.16	114	24.95	38	28.57
4. Circumference of a circle	38	22.75	147	32.17	51	38.35	83	49.70	185	40.48	49	36.84
5. Diameter of a circle	50	29.94	192	42.01	70	52.63	32	19.16	114	24.95	30	22.56
6.Radius of a circle	22	13.17	93	20.35	41	30.83	32	19.16	81	17.72	33	24.81
7.Sector of a circle	19	11.38	91	19.91	42	31.58	31	18.56	73	15.97	28	21.05
8.Segment of a circle	59	35.33	174	38.07	61	45.86	24	14.37	82	17.94	21	15.79
	100	59.88	281	61.49	84	63.16	31	18.56	102	22.32	33	24.81
9.Chord of a circle	36	21.56	127	27.79	49	36.84	39	23.35	58	12.69	28	21.05
10.A secant of a circle	136	81.44	409	89.50	127	95.48	24	14.37	22	4.81	5	3.76
11.A tangent to a circle	76	45.51	235	51.42	80	60.15	29	17.37	84	18.38	30	22.56
12. A quadrilateral	40	23.95	143	31.29	57	42.86	20	11.98	73	15.97	27	20.30
13. A quadrilateral with equal sides and equal angles	70	41.92	240	52.52	81	60.90	6	3.59	20	4.38	4	3.01
14.A polygon	84	50.30	238	52.08	85	63.91	18	10.78	58	12.69	20	15.04
15.Sum of exterior angles of a polygon	94	56.29	258	56.45	80	60.15	9	5.39	18	3.94	8	6.01
16.Area of a plane shape	118	70.66	338	73.96	115	86.47	38	22.75	104	22.76	15	11.28
17. Perimeter of a plane shape												

18. An angle	110	65.87	316	69.15	109	81.95	27	16.17	93	20.35	17	12.78
19. A vertex	81	48.50	230	50.33	86	64.66	47	28.14	132	28.88	33	24.81
20. A solid shape	110	65.87	316	69.15	103	77.44	9	5.39	47	10.28	9	6.77
21. A cube	105	62.87	333	72.87	104	78.19	25	14.97	67	14.66	15	11.28
22. A cuboid	74	44.31	222	48.58	82	61.65	29	17.37	104	22.76	28	21.05
23. An edge of a shape	87	52.10	283	61.93	99	74.44	40	23.95	94	20.57	18	13.53
24. An irregular shape	123	73.65	285	62.36	125	93.98	19	11.38	37	8.10	5	3.76
25. A good example of an irregular shape	108	64.67	346	75.71	103	77.44	31	18.56	71	15.54	17	12.78
26. The difference between a regular shape and an irregular shape	115	68.86	373	81.62	110	82.71	11	6.59	25	5.47	7	5.26
	104	62.27	356	77.90	108	81.20	39	23.35	67	14.66	15	11.28

Research Question 4: Is there any difference in the number of senior school students holding alternative conceptions of geometry based on academic ability level?

On the number of senior secondary school students holding alternative conceptions of geometry based on academic ability levels, the high academic ability level students and the low academic ability level students had higher percentages of students holding alternative conceptions of geometry in 9 items each. Medium academic ability levels students had higher percentages of students with alternative conceptions of geometry in 8 items of the GCT. Results from the present study on academic ability levels of students showed that there was no distinct difference in the number of senior secondary school students who are of different academic ability levels holding various types of conceptions of geometry. Table 3 revealed this result.
Research Hypothesis (H0): There is no significant difference in the number of senior secondary school students holding correct conceptions, misconceptions and alternative conceptions of geometry based on academic ability level.

The interpretation of the outcome of this hypothesis means that the differences in the percentages of students holding alternative conceptions of geometry was not much based on academic ability levels. The result of the chi-square test presented in table 4 clarified these findings. The calculated $\chi2 = 4.39$, Df = 4, p-value was 0.35. Since the p-value (0.35) was greater than 0.05 (level of significance), the hypothesis was retained. It was concluded that there was no significant difference in the number of senior secondary school students holding correct conceptions, misconceptions and alternative conceptions of geometry based on students' academic ability levels. This implies that academic ability levels of students had no significant influence on students' conceptions of geometry.

Table 4
Chi-square Analysis for Significant Difference in the Conceptions of Geometry Based on Students' Academic Ability Levels

Academic Ability Level	Conceptions	Df	Total	χ^2-value	Sig.	Decision

		Correct	Misconception	Alterative					
High	Observed	42	36	89		167			
	Expected	34.9	40.80	91.3		167.00			
Medium	Observed	93	110	254	4	457	4.39	0.35	Reject not $H0_2$
	Expected	95.40	111.70	249.90		457.00			
Low	Observed	23	39	71		133			
	Expected	27.80	32.50	72.70		133.00			
Total	Observed	158	185	414		757			
	Expected	158.00	185.00	414.00		757.00			

This finding was in line with the findings of Balogun (2010) on conception of thermodynamics held by colleges of education Chemistry students. The study reported that academic ability levels have no influence on students' conceptions of thermodynamics when exposed to Thermodynamics Conception Test. However, other previous studies with opposite views on students' academic ability levels include: Abdulraheem (2012) who worked on conceptions of Electromagnetism held by colleges of education Physics students. It was also not in line with Musa and Bolaji (2015) on the effect of laboratory approach on junior secondary school students' achievement in geometry and mensuration. These studies revealed that students held various conceptions in Physics and Mathematics and the various ability levels of students do influence their levels of conceptions in learning.

This implies that both teachers and the students need to watch out in every geometry class in order to minimize students' misconceptions and alternative conceptions in geometry.

Conclusion and Recommendations

The results of this study revealed that misconceptions and alternative conceptions held by students could influence their performance in geometry. However, there was no significant difference in the number of students holding correct conceptions, misconceptions and alternative conceptions of geometry based on academic ability levels. Both students and teachers could be assisted in guiding against misconceptions and alternative conceptions of geometry if these incorrect conceptions could be identified earlier before new knowledge on geometry are taught in the classroom. Also, making prompt corrections on the identified incorrect conceptions could help to reduce misconceptions and alternative conceptions of geometrical concepts. Specifically, the following recommendations are considered relevant based on the findings of this study:

1. Mathematics teachers should endeavor to find out the cause of students' poor performance in geometry topics whether it is as a result of misconceptions and alternative conceptions held by the students.
2. Mathematics teachers should pay more attention to the teaching of geometry by emphasizing on correct conceptions of concepts and sub-concepts of geometry. This will help students to understand and acquire correct conceptions of geometry.
3. The high academic ability level students should also be encouraged to work more exercises in geometry and not to be overconfident but guide against misconceptions and alternative conceptions of geometry.
4. Students should be encouraged by teachers to take time to study geometry in view of its importance to life as observed in physical structures around us. This will enhance correct

conceptions of the geometrical concepts thereby minimizing misconceptions and alternative conceptions of geometry.

5. Mathematics text book authors should guide against misconceptions and alternative conceptions in their publications in order to minimize incorrect conceptions of geometry.
6. The federal and state ministries of education, educational bodies and professional associations like, Nigeria Educational Research and Development Council (NERDC), Science Teachers' Association of Nigeria (STAN), Mathematical Association of Nigeria (MAN), should organize periodic in-service-training as well as regular workshops for teachers to update their knowledge on correct conception of geometry and reduce misconceptions and alternative conceptions of geometry and mathematics in general thereby improving teaching and learning for better performance of students.

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