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INVESTIGATION OF THE DIFFICULTIES SENIOR SECONDARY SCHOOL STUDENTS ENCOUNTER IN MENSURATION-BASED PROBLEM SOLVING IN LAGOS STATE

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ABSTRACT

The issue of failure in mathematics especially in the mensuration content of the curriculum despite its practical nature has been of great concern to all stakeholders of mathematics education. This study therefore investigated the difficulties that senior secondary school students encounter while solving problems in mensuration and the influence of gender on the level of difficulty experienced. The study adopted a descriptive survey design using quantitative methods. The sample consisted of 270 SS II students, (of which 144 were males and 126 were females) from two Education Districts in Lagos State. Three instruments; students' diagnostic test in mensuration, questionnaire in mensuration for students and questionnaire in mensuration for teachers with reliability coefficients of 0.82, 0.76 and 0.88 respectively were used for data collection. Data collected were analyzed using both descriptive and inferential statistics. Results showed that students' level of understanding in mensuration was low. It was found that the numerous difficulties that students encounter generally fall into categories; formulae, concept, language and procedure, and skills related difficulties. Acting subtly and indirectly compounding the level of difficulties encountered were some affective factors categorized as psychologically related difficulties. However, gender did not significantly influence the level of difficulty encountered. It was recommended that mathematics teachers should pay attention to these students' difficulties during instruction. This will enable them to tackle the difficulties and consequently improve students' achievement in mensuration and by extension, in mathematics.

Key words: difficulties, mensuration, problem solving, gender

INTRODUCTION

Mathematics and its methods have continued to play significant roles in humanity's quest for development. As a school subject, mathematics is a subject whose usage cuts across many other subjects and as a tool for societal development, its usage cuts across many

spheres of human endeavor. The learning of mathematics in schools equips students for the challenge of using mathematics and its methods as problem solving tools in the outside world (Dada &Babajide, 2019). It is in recognition of the vital role that mathematics plays in development that mathematics teaching has been accorded a special place in the educational system. Mathematics is a compulsory subject for all levels of education below the tertiary level and also a necessary requirement for entry into any higher institution in Nigeria (National Policy on Education, 2014). However, with the increasing importance of mathematics, several studies (Doosomah, 2008; Odogwu&Nna, 2013) have confirmed that the performance and achievement of students in the subject have been dismal.

The consistent poor achievement of students in mathematics suggests that students do encounter difficulties while solving mathematics problems. Howell (2000) cited by Yusha'u& Musa (2012) observed students' mathematics difficulties as being categorized into two; mathematics computational disabilities and mathematical reasoning disabilities. The poor achievements of students have been attributed to poor mathematical foundation (Odogo, 2012), lack of use of instructional aids and modern technology (Odogwu, 2011; Usman&Ezeh, 2011), students' attitude to and perception of mathematics (Oteze, 2011; Ijadunola & Lawal, 2016) and largely to the abstract nature of mathematics (Shafi&Areelu, 2010; Kurumeh, Chianson&Uhon, 2012), lack of understanding of mathematical concepts (Ebisine, 2010; Dada, Folorunsho& Johnson, 2019), etc. Although the nature of mathematics is primarily abstract, mensuration, unlike algebra is one branch of mathematics that is very practical. Mensuration is a part of geometry that deals with the calculation of geometric quantities such as length, area, volume, perimeter, etc. from dimensions and angles that are already known. Mensuration spans from primary one to senior secondary year three in the school mathematics curricula. The inclusion of mensuration in the curricula is essential because it draws students' attention and creates awareness to the beauty of mathematics inherent in geometric figures

around and within the environment. However, a track of studies conducted over many years ago on students' difficult areas of mathematics (Odogwu, 2002; Sule, 200g3; Salman, 2004) shows that for decades, students have been experiencing difficulties with mensuration and its concepts. Remarkable improvements have not been achieved with time. The Chief Examiner's report (2007) confirmed that mensuration was a leading area of students' weakness in mathematics and Evbuomwan (2013) showed that students have difficulties abstracting and deducing facts in transformation geometry. This weakness could be a consequence of some teachers' lack of commitment to the teaching of mathematics. Many a times, mathematics teachers skip difficult topics in mathematics (Harbor-Peters, 2002 in Ekwue & Umukoro, 2011). The study by Ekwue and Umukoro (2011) confirmed that many teachers of mathematics in senior secondary schools do not teach certain topics among which are logical reasoning and volume of similar solids because they consider them as topics that are difficult to teach. To assist or promote students' understanding in mathematics, the use of teaching aids is encouraged. The problem of unavailability of teaching instructional materials in mathematics is easy to overcome in the case of mensuration, improvisation is easier. The use of improvised teaching aids in mensuration produced significant improvement effect on the mathematics achievement of students (Etukudo, 2000 in Shafi & Areelu (2010)). Several studies (Abubakar, 2012; Ozokeraha & Oruche, 2019) have confirmed that the use of teaching aids; regalia or improvised, produces better achievement than not using any at all.

While students' achievement in mathematics has been generally below expectation, there has been a long standing unresolved debate about mathematical superiority between male and female students. A good number of research findings agree to the mathematical superiority of the male gender (Popoola& Ajani, 2011; Imoko & Anyagh, 2012) and the society generally subscribes to the same, but there have been records of females performing better than males either in mathematics at large or in specific content areas (Anagbogu & Ezeliora, 2007).

More recently, there are three different inclinations of research findings; male are mathematically superior (Popoola & Ajani, 2011; Imoko&Anyagh, 2012), females are mathematically superior (Anagbogu & Ezeliora, 2007) and, males and females are at par (Ijadunola & Lawal, 2016; Noureen & Sheikh, 2016). There is yet to be a consensus, thus promoting gender linked studies.

The findings of some studies cited above have ascertained that mensuration is one of the areas where students perform very poorly. This poor performance suggests that students do encounter difficulties while solving problems in mensuration. Also, there could be possible influence of gender on students' level of understanding in mensuration.

STATEMENT OF PROBLEM

Students' achievement in the mensuration content of the curricula should normally be better than the achievement in other content areas. This is because the practical nature of mensuration and the ready availability of instructional materials to aid students' understanding are credits for mensuration which some content areas of mathematics lack. However, the case is different as the achievement of students in this content area has been dismal.

The wide range of application of mensuration concepts makes it imperative for solutions paths be sought for the problem of poor achievement in mensuration. Otherwise, students who have gone through instructions in mensuration in school will not be able to apply what was learnt in solving problems outside the classroom. Research suggestions and instructional activities that have been documented for their ability to improve students' achievement in mathematics as a whole include but are not limited to; use of instructional aids, use of student-focused strategies and methods such as cooperative learning, getting students in hands on active learning and problem solving activities, focusing on students' attainment of proficiency in mathematics etc. The major challenge with wholesome approaches like

the ones suggested is that they may not cater for specific content peculiarities. This accounts for why the failure in mensuration has continued. An approach that might be very effective for improving students' achievement in mensuration but has received little or no attention by researchers is: identifying students' difficulties in mensuration. The identified difficulties may then be specifically or generally focused on and tackled during instructions. This is a gap which this study filled.

Furthermore, the influence of gender in determining the direction of mathematical superiority (or otherwise) could also be present in determining the type and level of difficulty that students encounter while solving mensuration problems. This study therefore also considered the possible influence of gender on the difficulties students encounter in mensuration.

PURPOSE OF THE STUDY

Following the problems of the study, the purpose of this study was to investigate the difficulties that senior secondary school students encounter in solving problems in mensuration. Specifically, the study assessed and determined students' level of understanding in mensuration and the influence of gender on the level of understanding. It also identified students' difficulties in mensuration problem solving.

Research Questions

The following research questions guided the study.

1. What is senior secondary school students' level of understanding in mensuration?
2. What is the influence of gender on students' level of understanding in mensuration?
3. What are the difficulties encountered by senior secondary school students in solving problems in mensuration?

Research Hypotheses

The following null hypotheses were formulated for the study and tested at a 0.05 level of significance.

1. There is no significant difference between students' level of understanding and the pass mark level of understanding in mensuration.
2. There is no significant influence of gender on students' level of understanding in mensuration.

METHODOLOGY

The study adopted a descriptive survey design using quantitative methods. The study was conducted in Education Districts II and IV of Lagos State. The investigation was carried out using two hundred and seventy (270) senior secondary year two students. There were one hundred and forty four (144) male and one hundred and twenty six (126) female students. The students who participated in the study were students from a total of six purposively chosen intact classes in the Education Districts. Three schools were chosen from each Education District and one school was chosen from each of the three Local Government Areas that made up the ED. Intact classes were used because of the nature of the investigation. Randomly choosing individual students could produce a skewed sample, which will not be favorable for the type of investigation. However, in intact classes, students' mathematical ability and other factors are usually normally distributed. This will make the findings more encompassing and obtainable in many typical classroom settings. Three research instruments consisting of a Students' Diagnostic Test in Mensuration (SDTM), a Questionnaire in Mensuration for Students (QMS) and a Questionnaire in Mensuration for Teachers (QMT) were used for data collection. The reliability coefficients obtained for the SDMT, QMS and QMT were 0.82, 0.76 and 0.88 respectively. Cronbach alpha was used for each instrument at a single administration. The SDTM consisted of two sections; demographic data (gender and age) and problem solving sections. The problem solving section consisted of five well-structured questions in mensuration. Specified figures in the curricula such as

triangles, rectangles, circle, cylinder, cube, cuboid and prism were covered. The concepts coverage included length, area and volume. The QMS gathered information relating to students' views about and their attitude to mensuration, the difficulties they (students) encounter in solving problems in mensuration and possible ways in which they (students) could be helped to improve their performance in the content area from students themselves. The QMT gathered information from teachers about students' attitude to and performance in mensuration, the difficulties students encounter in mensuration, possible solutions proffered by the teachers and the problems themselves (teachers) encounter in teaching mensuration.

The SDTM was conducted in all the schools with the assistance of the class teachers. This was done in order to reduce students' anxiety due to the presence of an external examiner. In some of the study schools, teachers administered the QMS before while some administered after the SDTM. Students' problem solving procedures (answers) to the SDTM were marked using a comprehensive marking guide to get their achievement scores. The maximum obtainable score was 100. The problem solving procedures in the answer scripts were then examined to get the difficulties that students encountered.

The analyses of data were done using simple frequency counts, means and percentages. Raised hypotheses 1 and 2 were tested using the one sample t-test and the independent samples t-test respectively at 5% level of significance.

RESULTS

The results of the study are presented in line with research questions

Q 1: What is senior secondary school students' level of understanding in mensuration?

This question was answered using students' achievement scores in mensuration. Table 1 below contains the descriptive statistics of students' scores

Table 1: Descriptive statistics of students' achievement scores in mensuration

N	sum	Sample mean	Mean percent	Standard deviation	variance
270	9051	33.52	33.52	26.27	690.13

Table 1 above shows that students had a mean score of 33.52 with a standard deviation of 26.27 in the diagnostic test. The mean percentage was 33.52%. This percentage was lower than 40% which is regarded as the minimum pass mark in government owned schools.

H_o 1: There is no significant difference between students' level of understanding and the pass mark level of understanding in mensuration.

Students' mean score of 33.52 was tested against the pass mark of 40 using a one sample t-test. The result of the one sample t-test is contained in table 2 below.

Table 2: One sample t-test of the difference between students' level of understanding and pass level of understanding

	Test value = 40 t	df	Sig (2-tailed)	Mean difference
Level of understanding in mensuration	-4.1783	269	0.001	6.68

Table 2 above shows a t-value of 4.1783 with $p < 0.05$ (df =269). This is significant. Hence,there was significant difference between students' level of understanding in mensuration and the level of understanding required for a pass in mensuration. The null hypothesis was rejected. Hence students' level of understanding in mensuration was low.

Q 2: What is the influence of gender on students' level of understanding in mensuration?

Below is the descriptive statistics of students' scores in the SDTM based on gender

Table 3: descriptive statistics of students' scores in the students' diagnostic test in mensuration based on gender

Gender	N	mean	Standard deviation
Male	144	34.09	24.71
Female	126	32.44	25.99

Table 3 above shows that the male students had a mean score 34.09 with a standard deviation of 24.71 while the female students had a mean score of 32.44 with a standard deviation of 25.99. The male group had a mean score that was marginally greater than the mean score of the female group by 1.65.Hence, male students performed marginally better than female students.

H_o 2: There is no significant influence of gender on students' level of understanding in mensuration

The null hypothesis above was tested using the independent samples t-test. Table 4 below contains the result.

Table 4: Independent samples t-test of students' scores based on male and female groups

t-calculated	df	Mean difference	t-critical	Sig. level
0.5343	268	1.65	1.989	0.05

With t-calculated (0.5343) being less than t-critical (1.969), we fail to reject the null hypothesis. Therefore, there was no significance influence of gender on students' level of understanding in mensuration. This implies that male and female students performed equivalently

Q.3. what are the difficulties encountered by senior secondary school students in solving problems in mensuration?

Answers were provided to this question by examining students' answer scripts and also using the responses provided by teachers and students in the QMT and QMS respectively.

The difficulties observed for students were grouped as formulae, concept, language and procedure, skills and psychological related problems. The majority of difficulties were formulae related. Difficulties under this group include: inability to recall basic formulae correctly, apply formulae correctly, derive correct formulae by themselves and decipher between the formulae i.e., the best to use depending on given data.

The concept related difficulties were; lack of understanding of concepts in mensuration and other connecting concepts in mathematics (squares, square roots, ratio and angles, units of measurements) and inability to state and apply mensuration related theorems.

The language and procedure related difficulties were lack of proper understanding of mathematical and English languages and improper interpretation of problems. This category of difficulties was obviously manifested in students' mistakes. The common mistakes were: placement mistake, bracket opening mistakes, cross over mistakes, inability to translate the word problems to algebraic expressions or equations, use of numbers instead of letters to represent unknowns, use of given data to get the unknown (wrong steps in procedures involved) and inability to establish a relationship between the given data and the unknown.

The skills related problems included; lack of drawing psychomotor skills, inability to communicate thought lines clearly using diagrams, and inability to visualize shapes, represent three dimensions on paper or translate the problems into diagrammatic forms.

The psychological related difficulties are affective in nature. Examples are: hatred for mathematics and mathematics teachers, fear of mathematics and failure, inconsistency in practice and exercises, lack of quality self-concept, self- intimidation and lack of confidence in one's abilities.

DISCUSSION OF FINDINGS

Students' achievement in mathematics has been abysmal for several years (Dada & Babajide, 2019). This study found that students' level of understanding in mensuration was low. This indicates that students lack proper understanding of concepts in mensuration. This lack of proper understanding of concepts in mathematics was reported by (Dada, Folorunsho & Johnson, 2019).The finding agrees totally with previous studies (Doosomah, 2008; Odogwu & Nna, 2013) that showed students' achievement in mathematics and mensuration to be poor. It further confirms the fact that mensuration is one of the difficult areas of mathematics for students.

The study found no significant difference between the levels of understanding in mensuration exhibited by male and female students in the study. This result agrees with the findings of some previous studies (Ijadunola & Lawal, 2016; Noureen & Sheikh, 2016) who also found no significant difference between the achievements of male and female students. In fact, Noureen & Sheikh (2016) reported that male and female students' achievements in mathematics area strands like whole numbers, integers, ratio and proportion, algebra, area and perimeter, volume and surface area were at par. It however disagrees with the significant mathematical superiority reported by (Popoola & Ajani, 2011; Imoko & Anyagh, 2012) in favour of the males and by (Anagbogu & Ezeliora, 2007) in favor of the females.

The study found and categorized students difficulties in mensuration into five groups; formulae, concept, language and procedure, skills and psychological related difficulties. While the major difficulties were connected to formulae, psychological difficulties were acting subtly and remotely to influence the level of difficulties that students encountered. Consequent on formulae related difficulties, many students muddled up formulae; self- generated wrong formulae and wrote entirely wrong and unconnected formulae. The inability of students to draw required shapes or correctly put up a diagram depicted

by the question in mensuration has the potential to affect every other area of mathematics. In mathematics, it is of great value to be able to represent three dimensional configurations and to comprehend the geometric relationship that exists among various parts of the figure. The study also found that students have difficulty translating word problems into mathematical expressions or equations. Salman (2004) classified this difficulty (which students commonly encountered in algebra) as supposition error. Supposition error is the inability to represent unknowns with letters, supposing the letter(s) to stand in for the unknown in the solution procedure.

The difficulty of supposition could have possibly emanated from students' mathematical and English languages problems. When problem contexts which are expressed in English language are either not understood or misunderstood, the problem solver will not be able to solve the problem (Dada & Babajide, 2019). The misunderstanding of mathematical and English languages found as a difficulty of students in this study aligns with Ebisine's (2010) finding that students lack understanding of technical words which are also mathematical concepts. The skills related difficulties that students encountered in mensuration suggest that students will also demonstrate such skills related difficulties in mathematics and other science related subjects. This assertion is in line with the findings of Badiru (2003) and Oteze (2011).Badiru (2003) found that there is a high positive correlation between students' proficiency in some mathematical skills and their performance in other science subjects. Oteze (2011) observed that students had difficulties with conceptual and procedural skills in mathematics. More so, the skills related problems point to the fact that students do not possess to an acceptable level the skills that are needed in mensuration and by extension in mathematics for optimum performance.

CONCLUSION

This study has established that students' level of understanding in mensuration is low. This further affirms that mensuration is one of the difficult content areas for students. It has shown that male and female students' levels of understanding in mensuration are at par. Unlike in many other mathematics content area where there males were found to be significantly better than the females, the results obtained in this study agrees with the mathematical equivalence of male and female students. It has established that students' problem solving difficulties fall into five broad categories; formulae, concepts, skills, language and procedure, and psychological related difficulties. These groups of difficulty have the power to influence every other area of mathematics if not attended to.

RECOMMENDATION

Based on the findings of the study, it was recommended that teachers of mathematics pay attention to building of concepts during instruction. When foundational concepts are understood by students, it will enable them to overcome difficulties associated with lack of proper understanding of concepts. Teachers should guide students into generating formulae by themselves. This will particularly help students to overcome difficulties associated with recalling of formulae. Teachers are to note areas where students mostly encounter difficulties and try to clear or reduce the prevalence of the difficulties by spending more time with students in those areas. Teachers of mathematics should be kind and approachable. This will enable students develop deeper interest in mathematics and also feel free to meet the teacher for clarifications when confronted with challenges.

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