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EFFECTS OF CHARTS WITH DEMONSTRATIVE AND COLLABORATIVE INSTRUCTIONAL APPROACHES IN STUDENTS' ACHIEVEMENT ON MENSURATION

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ABSTRACT: *This study investigated the possible effects the use of charts might have on students' understanding of the concept of mensuration using demonstration and collaborative instructional approaches. Two research questions and two null hypotheses guided the study. The quasi-experimental research design was employed to conduct the study. A sample of 105 drawn from a population of 800 senior secondary school two students in Okrika Local Government Area of Rivers State Nigeria. The instrument used to collect data was Test on Understanding of the Concept of Mensuration (TUCM). TUCM was validated and the KR-20 formula was used to establish a reliability of .86. The research questions were answered descriptively using mean, standard deviation, and graph while the hypotheses were tested inferentially at .05 level of significance using Analysis of Covariance (ANCOVA). The result showed that students taught using demonstration instructional approach with chart understood the concept of mensuration better than those taught with collaborative approach with chart. There was also a significant difference between the mean gain of students taught using demonstration approach with chart and those taught using collaborative approach with chart. There was no significant difference between male and female students' understanding of the concept of mensuration when taught with chart using demonstration and collaborative approaches. It was recommended among others that mathematics teachers should teach mensuration with charts using demonstration approach.*

KEYWORDS: Pre-Test, Post-Test, Mean Grand Score, Students, Education

INTRODUCTION

The mathematics curriculum at the pre-tertiary level is divided into different strands or themes. Each theme has a broad content. The different themes include but not limited to Number & Numeration, Algebra, Mensuration, Mechanics, Geometry, Probability and Statistics. All the themes in the mathematics curriculum are important. There is no theme that is of more importance than the other because the knowledge of each theme's content helps in the understanding of other theme's contents (Adams, 2009). This implies that all the themes are interrelated both horizontally and vertically. Mathematics is a compulsory subject at the pre-tertiary levels of education and every student is expected to study all the topics in the different themes. It should be noted that the different themes are not compartmentalised but rather are interwoven.

Mensuration is a branch of mathematics which deals generally with geometric shapes and measurement. Ask.com (2016) defined mensuration as a branch of mathematics which deals

with the measurement of areas and volumes of different geometrical figures. The related parameters which are taught in mensuration include but not limited to types and properties of geometric shapes (plane or solid), the measurement of the dimensions that form the shapes, the diagrams and nets of the shapes, the area and volumes of the shapes, the properties of the shapes, the relationships between the properties of the shapes, the development and use of formula to solve mensuration problems. A close look at the content of mensuration shows that it is taught at the pre-primary, primary, post-primary and tertiary institutions. At whatever level it is taught, the nature of the mensuration contents calls for the teacher to employ a method that will enhance students' understanding of the concepts in the theme. The teaching and learning of the topics in the mensuration theme requires both teacher activities and students' activities that are relevant to the understanding of the contents. The content of mensuration at the senior secondary school requires students to have a pre-requisite knowledge and understanding of concepts such as measurements, shapes (plane and solid), lines, angles, nets of solids, interpolation, formulae and numerical computational skills. Memorization of mensuration formulae by students does not boost their understanding of mensuration concepts and development of computational skills.

For students to understand the concept of mensuration, the teacher needs to bring in real-life objects during teaching. But Pancare (2016) posited that the use of visual presentations in the classroom is a common effective teaching method. Charts are examples of visual representations. The use of charts as visual representation to teach mensuration will help students to understand the ideas being taught. This is because there are some mensuration concepts that the use of only real life objects cannot really represent in totality. Charts play vital role in developing a better understanding of the mensuration concepts along with making connections within and between concepts. Alamina (2008) stated that charts are used by teachers to represent abstract ideas. It is very important that students understand the mensuration concepts that are taught since they continue to come across mensuration in their subsequent classes in a spirally integrated mathematics curriculum. Abayomi (2009) opined that charts help students to make connections and applications. For charts to meet the needs of students and actually enhance their understanding in mensuration, the charts need to be well prepared, relevant and appropriate to the particular mensuration concept being taught. To this end, George (2012) outlined the following as the characteristics of a good instructional chart.

1. Must have a title
2. Must be bold and centralised.
3. Must not represent so many concepts at a time.
4. Must have margin
5. Must comply to colour harmony rules.
6. Must not be artistic.
7. Must be labelled horizontally.

The use of instructional charts by the teacher to teach topics that fall under mensuration theme can be done alongside with any of the well-researched teaching methods. The use of charts for teaching mensuration is highly advantageous because it unfolds a whole lot of abstract ideas that real life models may not unfold. Odogwu (2015) posited that the unique nature of mathematics (abstract, hierarchy of concepts, use of symbols and notation, computation, estimation, approximation, visualization, proofs, induction, deduction and logical reasoning) demands the use of instructional materials in the teaching and learning of mathematics to enhance students understanding of mathematics concepts and also demystify any doubt,

misconception or wrong belief in the students. Martinelli and Mraz (2013) opined that charts help to make teaching visible and also make students to understand and use what they have learnt. In as much as research has shown that the use of charts for instructional purposes make students understand the concept of mensuration, it is equally important for the teacher to use the chart effectively. Instructional charts can be used for demonstration, practical, collaboration, etc. Each of these strategies calls for skilful and effective use of the chart.

The demonstration instructional approach simply means the use of apparatus (instructional materials) by the teacher to clearly show and explain the concepts being taught with convincing reasons or proofs. This approach involves displaying of the right instructional material, coaching the students with the aid of the instructional material to understand the concept at hand and drilling the students. On the other hand, the collaborative instructional approach is a learner-centred setting that allows the students to exchange ideas and interact with peers and facilitators. The use of demonstration or collaborative approach is challenging; therefore, the teacher has to possess the required skill.

Struble (2007) asserted that KWL chart is useful to complete formative assessment in the classroom and it also allows the teachers to find out students' prior knowledge in a particular topic in mathematics (geometry and mensuration). Charles-Ogan, Onwioduokit and Ogunkunle (2014) investigated mathematics laboratory and students' conception of mensuration using demonsatration and collaborative approaches and found out that students who were taught mensuration using demonstration with mathematics laboratory approach outperformed their counterparts and that gender factor did not significantly affect students' conception of mensuration.

The Nigerian version of the WAEC Chief examiners report (2012) emphasized that most students steer clear of answering any question in mensuration. This singular attitude of the students reveal that something is wrong in the teaching and students' improper understanding of the concepts in the mensuration theme. The researchers feel that students do not understand the mensuration concepts they are taught as a result of insufficient and inadequate use of instructional charts in addition to whatever real life instructional model that is available. This study was therefore carried out to investigate the effects of use of charts on students' understanding of the concept of mensuration using demonstration and collaborative instructional approaches.

Problem Statement

Mathematics teachers always complain that mathematics as a subject lack enough instructional materials to concretize the teaching of mathematics concepts. The commonest instructional material is the chart. Charts can be bought (industrial) or locally prepared by either the teachers or the students. The researchers have observed with dismay that most mathematics teachers carry out instruction on mensuration without the use of charts and the few that employ charts use it monotonously. How then will students understand the concept of mensuration and begin to answer questions on them in examination? This study is therefore set out to explore the possible effects the use of charts may have on students' understanding of the concept of mensuration using demonstration and collaborative instructional approaches.

Objectives of the Study

This study's objectives are to:

1. Ascertain the effect of use of charts on students' understanding of the concept of mensuration using demonstration and collaboration approaches.

2. Determine the effect of use of charts on the male and female students' understanding of the concept of mensuration using demonstration and collaboration approaches.

Research Questions

1. What effect has the use of charts on students' understanding of the concept of mensuration using demonstration and collaboration approaches?

2. To what extent does the use of charts affect the male and female students' understanding of the concept of mensuration?

Hypotheses

Two null hypotheses were tested at .05 significant level.

Ho_1: There is no significant difference between the students' understanding of the concept of mensuration when taught with charts using demonstration and collaborative approaches.

Ho_2: There is no significant difference between the male and female students' understanding of the concept of mensuration when taught with charts using demonstration and collaborative approaches.

METHODOLOGY

This study adopted the pretest-posttest equivalent quasi-experimental intact class research design. The design was 2X2X3 factorial. Two experimental groups and one control group were presented. Experimental group one was taught the concept of mensuration with chart using demonstration instructional approach, experimental group two was taught the concept of mensuration with chart using collaboration instructional approach while the control group was taught the same mensuration concepts using the conventional instructional approach. The study was set in Okrika Local Government Area of Rivers State, Nigeria. The population for this study was comprised of about eight-hundred (800) senior secondary two (SS2) students in the six (6) co-educational public senior secondary schools in Okrika Local Government Area of Rivers State, Nigeria. The sample size was 105 students, drawn from the three schools. To ensure that there is relationship in the academic ability of the students, the first 35 students based on third term results in mathematics in each of the schools formed the sample size.

The name of the instrument used to collect data was Test on Understanding of the Concept of Mensuration (TUCM). TUCM measured students' understanding of the concept of mensuration. There were 50 multiple choice questions in TUCM. Each question had four options (lettered A to D). Three of the options were distracters and only one option was the correct answer. A table of specification which guided the allocation of questions into the cognitive (lower and higher) learning domains was prepared by the researchers. Each correct answer was scored one mark and each wrong answer was scored zero mark. The total score for TUCM was 50. TUCM was face and content validated by two mathematics educators. A

reliability coefficient of 0.86 was established for TUCM based on the data obtained from a pilot study using the KR-20 Formula, stated thus: $K-R20=\frac{n}{n-1}\left[1-\frac{\sum pq}{\delta^2}\right]$

Where n is number of items, p= proportion that answered the items correctly, q= proportion that answered the items wrongly and δ^2 = variance of the test scores.

TUCM was used to pre-test students in the two experimental groups and one control group. After the pretest, the three groups were treated with instructional approach thus:

Group		**Instructional Approaches**
Experiment group 1	-	Demonstration approach with chart
Experiment group 2	-	Collaborative approach with chart
Control group	-	Conventional approach

After each group was taught with the above specified instructional approach, a posttest of TUCM was administered to the three groups. Their responses were graded and their scores were obtained. The descriptive statistical tool (mean, standard deviation, and graph) was used to answer the research questions while the hypotheses were tested inferentially at .05 level of significance using Analysis of Covariance (ANCOVA).

RESULTS

Research Question 1: What effect has the use of charts on students' understanding of the concept of mensuration using demonstration and collaboration approaches?

Table 1: Gain scores of charts on students' understanding of mensuration

Approach	**N**	**Pre-test**		**Post-test**		**Mean Gain Score**	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Demonstration with chart	35	24.74	9.38	59.26	11.32	34.51	14.26
Collaboration with chart	35	36.86	10.27	61.20	8.08	24.34	12.21
Conventional approach	35	32.23	7.27	51.43	10.12	19.20	13.71

Table 1 showed that the students taught using demonstration with chart had mean gain of 34.51 ± 14.26, those taught using collaboration with chart had 24.34 ± 12.21 and those taught using the conventional approach had mean score of 19.71 ± 13.71. Below is the graph of table 1.

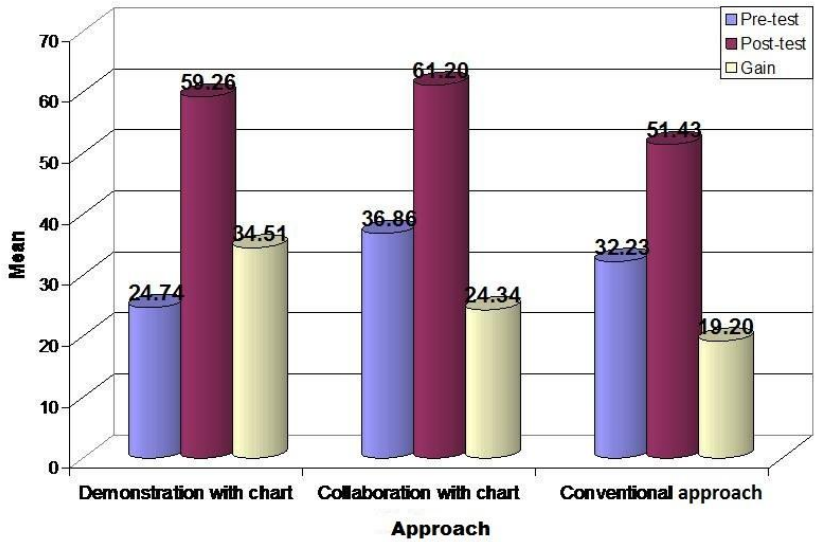

Fig. 1: Mean scores of students on the understanding of concepts based on different chart activity based approaches

Research Question 2: To what extent does the use of chart affect the male and female students' understanding of the concept of mensuration?

Table 2: Gain score of charts on male and female students understanding of concept of mensuration

Group	Gender	N	Pretest Mean	SD	Posttest Mean	SD	Mean Score Gain	
							Mean	SD
Demonstration	Male	20	27.90	7.30	59.10	10.17	31.20	13.94
with chart	Female	15	20.53	10.41	59.47	13.09	38.93	13.92
Collaboration	Male	21	37.43	10.81	61.43	7.08	24.00	13.50
with chart	Female	14	36.00	9.73	60.86	9.67	24.86	10.46
Conventional	Male	18	31.22	7.10	49.22	6.44	18.00	9.05
approach	Female	17	33.30	7.51	53.77	12.75	20.48	17.59

Table 2 showed that the mean gain score in conceptual understanding of mensuration among male students taught using Demonstration with chart was 31.20 ± 13.94, while that of their female counterparts was 38.93 ± 13.96. The mean gain of male students taught using Collaboration with chart was 24.00 ± 13.50 while that of their female counterparts was 24.86 ± 10.46. The male students taught using the conventional approach had mean score of 18.00 ± 9.05 while their female counterparts had 20.48 ± 17.59. Below is the graph of table 2.

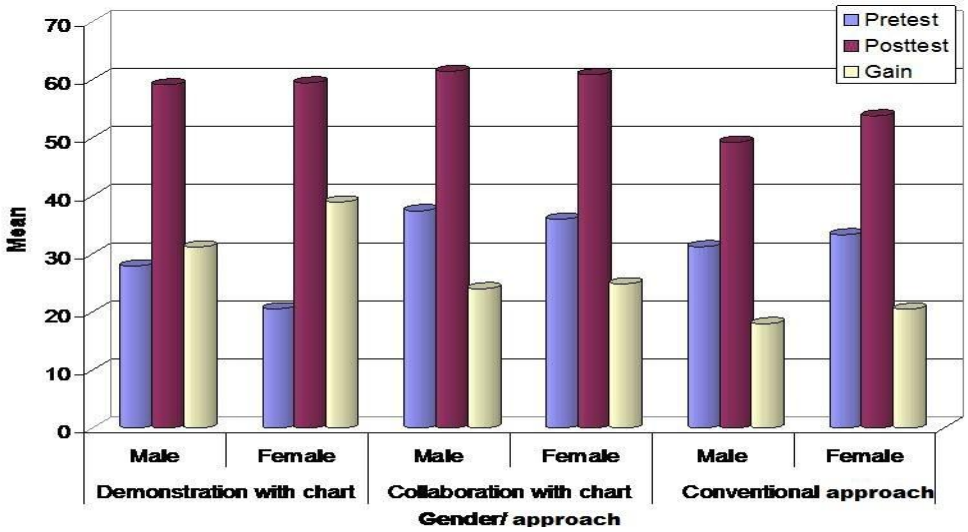

Fig. 2: Gain score of male and female students on the understanding of concept of mensuration when taught using chart activities

HO1: There is no significant difference between the students' understanding of the concept of mensuration when taught with chart using demonstration and collaborative approaches.

Table 3a: Summary of ANCOVA on the difference between the students' understanding of the concept of mensuration when taught with charts using demonstration and collaborative approaches

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1873.11[a]	3	624.37	6.27	.00
Intercept	25884.99	1	25884.99	259.81	.00
Pretest	.12	1	.12	.001	.97
Approach	1871.05	2	935.53	9.39	.00
Error	10062.73	101	99.63		
Total	356624.00	105			
Corrected Total	11935.85	104			

a. R Squared = .157 (Adjusted R Squared = .132)

Table 3a showed that there is significant difference between the students understanding of the concept of mensuration when taught with chart using demonstration and collaborative approaches ($F_{2, 101}=9.390$, $p<.05$). The hypothesis one was therefore rejected.

Table 3b: Post hoc test on the difference between the students' understanding of the concept of mensuration when taught with chart using demonstration and collaborative approaches

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.[a]
Demonstration with chart	Collaboration with chart	1.90	2.73	.00
	Conventional method	7.86*	2.52	.00
Collaboration with chart	Demonstration with chart	-1.90	2.73	.00
	Conventional method	9.75*	2.44	.49
Conventional Approach	Demonstration with chart	-7.86*	2.52	.00
	Collaboration with chart	-9.75*	2.44	.49

Table 3b indicated that the mean difference between EGI and EG2 was significant and in favour of EGI (MD=1.90, P<.05) This showed that the EG1 was most effective i.e. demonstration approach with chart.

HO2: There is no significant difference between the male and female students' understanding of the concept of mensuration when taught with charts using demonstration and collaborative approaches.

Table 4: Summary of ANCOVA on the difference between the male and female students' understanding of the concept of mensuration when taught with chart using demonstration and collaborative approaches

Source of variation	Sum of Squares	Df	Mean Square	Mean Gain Score	
				Mean	Sig.
Corrected Model	2057.44[a]	6	342.91	3.40	.00
Intercept	24896.50	1	24896.50	246.99	.00
Pretest	.15	1	.15	.00	.97
Approach	1809.94	2	904.97	8.98	.00
Gender	52.17	1	52.17	.52	.47
Approach * Gender	126.45	2	63.24	.63	.54
Error	9878.41	98	100.80		
Total	356624.00	105			
Corrected Total	11935.85	104			

a. R Squared = .172 (Adjusted R Squared = .122)

Table 4 showed that there is no significant difference between male and female students' understanding of the concept of mensuration when taught with charts using demonstration and collaborative approaches respectively (F1, 98= .52, p>.05). Hypothesis two was therefore retained.

DISCUSSION OF FINDINGS

Effect of the use of chart on students' understanding of the concept of mensuration using demonstration and collaborative approaches

The result on Table 1 showed that students who were taught with chart using demonstration approach had the highest learning gain in conceptual understanding of mensuration among the three groups compared. Furthermore, the result on Table 3 showed that there was significant difference between the students understanding of the concept of mensuration when taught with chart activities using demonstration and collaborative approaches ($F2, 101=9.39, p<.05$). The hypothesis two was rejected. The result of the present study is consistent with the earlier studies of Struble (2007) who asserted that KWL chart is useful to complete formative assessment in the classroom and that it allows the teachers to find out students' prior knowledge in a particular topic in mathematics (geometry and mensuration). This is in line with the findings of Charles-Ogan, Onwioduokit and Ogunkunle (2014) who established that students taught mensuration using demonstration approach with mathematics laboratory (charts) outperformed those who were taught without mathematics laboratory (charts).

The use of chart on male and female students' understanding of the concept of mensuration

The result on Table 2 showed that the highest mean gain in understanding of the concept of mensuration was had by the female students who were taught with chart using the demonstration approach while the male students who were taught with the conventional approach had the least gain in learning. Furthermore, Table 4 showed that there was no significant difference between male and female students' understanding of the concept of mensuration when taught with chart activities using demonstration and collaborative approaches respectively ($F1, 98= .52, p>.05$). The hypothesis two was retained. This is consistent with the findings of Charles-Ogan, Onwioduokit and Ogunkunle (2014) who found out that gender did not significantly affect students' conception of mensuration using mathematics laboratory with demonstration and collaborative approach.

CONCLUSION

This study concluded that the group of students who were taught mensuration concepts with charts using demonstration approach had higher understanding of the concepts than those in the group that were taught with charts using collaboration instructional approach. The study also concluded that no gender difference existed in the students' understanding of the concept of mensuration when taught with chart using the demonstration and collaboration instructional approach.

RECOMMENDATIONS

The findings of this study led the researchers to recommend the following:

1. For students to effectively understand the concept of mensuration, mathematics teachers should use instructional materials such as charts to teach in addition to available real-life models.

2. Teachers should vary the instructional approaches when they employ charts to teach mathematics concepts in general and mensuration concepts in specific.
3. Gender of the students should be considered when teaching mensuration.
4. Teachers should endeavour to produce instructional charts for the teaching of abstract concepts.
5. Mathematics teachers should make a u-turn from the use of conventional approach to teach mathematics to well researched modern approaches.

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