# Effect of Geo-Board and Charts on Students' Achievement in Mathematics in Essien Udim, Akwa Ibom State, Nigeria

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## ABSTRACT

*The study determines the effects of geo-board and charts on students' achievement in mathematics in Essien Udim, Akwa Ibom State, Nigeria. Three each of research questions and hypotheses guided the study. The design was a quasi-experimental design using pretest and posttest non randomized design. The population was all the Junior Secondary one mathematics students for the year 2022/2023 session in the 11 public Secondary Schools. A sample of 126 students was selected. Simple random sampling technique was used to select the schools. The instrument for data collection was Geometry Achievement Test (GAT). The instrument was designed by the researchers and validated by a panel of four experts all from the Department of Science Education, Akwa Ibom State University, Mkpat Enin. GAT has a reliability index of 0.79. Two learning packages (one each for geo-board and chart instructional materials groups) were prepared by the researchers and used in teaching the students the concept of geometry based on the objectives of the study. The data collected in the course of the study were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA), using pretest and posttest scores as covariates. The findings of the study showed that; there was a significant difference between the mean achievement scores of students' in Geometry when taught using geo-board and charts, male students significantly achieved more than the female students in the concept of geometry in mathematics and there was a significant interaction effect of gender and instructional materials in the concept of geometry in mathematics, based on these findings, it was recommended that geo-board should be used by the teachers in the teaching of the concept of geometry in mathematics.*

*Keywords: Geo-board, charts, mathematics, students' achievement*

## INTRODUCTION

Mathematics is the science of numeracy cutting across several human activities all over the world. Thus, there is nothing human beings do that mathematics is not part of it. The

conception, period of conception, date of delivery and other numerical records are all products of mathematics. Children are naturally curios about the subject mathematics, and come to school with a view of knowing much about mathematics and its other concepts which geometry is a part (Utibe, Agah, Usman & Akpan, 2018).

Utibe and Agwagah (2016) see mathematics as an essential tool in the information of the educated man. Its application in other disciplines, mostly in the sciences is appreciative and without it, knowledge of the sciences often remains superficial. In Nigeria, mathematics is taught as a core subject to all students at the primary and secondary school levels in order to give a sound basis for scientific and reflective thinking and to prepare student for the next level of education (FRN, 2014). In spite of the importance and popularity of mathematics among Nigerian students, performance at Senior Secondary School level had been poor (Utibe & Agwagah, 2015). Studies have shown that Nigerian students' achievements in secondary school mathematics have been relatively low over the years. (Agwagah, Utibe & Uko, 2011 & Akwa Ibom State MOE, Examination Unit, 2023).

Mathematics has several branches and some of these branches appear to be more difficult for teachers to teach and students to learn than others (Agah, Sule & Utibe, 2013). The basic geometry at junior secondary level consider in this study is one of them. Research findings have suggested that geometry is one of the topics that appear as abstract and complex aspects of mathematics, which students may find difficult to learn, and some teachers may find difficult to teach without the use of instructional materials (Utibe & Onwiouokit, 2019). Geometry is the branch of mathematics that deals with the nature, properties, measurement and relationships of points, lines, angles and figures in space. It is a collection of rules for computing lengths, areas and volumes of objects (Utibe, Agah, Usman & Akpan, 2018).

Instructional materials can be used in promoting students interest and achievement in mathematics. Models, geo-board and charts have potentials in promoting the teaching of geometry (Utibe & Agwagah, 2016). The study also stressed that instructional materials can enhance visual imagery, stimulates learning and assists a teacher to properly teach the topic content to the learner in order to achieve better achievement.

Geo-board instructional material is a device consisting of wooden board with rows and columns of protruding nails. Utibe, Agah, Usman and Akpan (2018), describes Geo-board as a rectangular board with nails nailed into its surfaces in such a way that they maintain equal intervals among themselves. In using Geo-board in teaching mathematics, rubber bands or threads are sued to connect the required nails to form appropriate shape(s). This may provide practical experience for the students. Geo-Board has an attribute of illustrating the given concept from its components which may provide enough activities for the students. The concept of geometry will lead to the trace of plane shapes on the geo-board, and it may provide for individual differences since it can be seen, touched and so on.

Unlike chart instructional material, it is a fixed drawing of different types of geometrical shapes on either wooden or card boards or flip-paper. Charts are standard drawings of different types of geometrical shapes showing their details such as length, angles,

and other dimensions. In using charts in teaching mathematics, a teacher points and refers students from figure/shape to the other depending on the appropriate shape(s) taught at that particular time. This may provide practical experience for the students. Chart has an attribute of illustrating the given concept from its components which may provide enough activities for the students. The concept of geometry will lead to the trace of plane shapes on the chart, and it may provide for individual differences since it can be seen and touched by the students (Utibe, Agah, Usman & Akpan, 2018).

Achievement is the capability to operate efficiently, react quickly or perfectly to a given task. Therefore, to achieve is to accomplish, acquire or gain by effort or do something successfully with an effort or skill. It describes the level of success in relation to a task or job carried out. Academic achievement is an outcome of teaching and learning encountered. It reflects the extent to which students have attained their educational stated objectives as well as students' cognitive attainment in the core subject at school level. Academic achievement has become an index of a child's future in the competitive world. In order to develop an identity in the society, children are becoming more concerned about their academic achievement. Students' academic achievement may differ due to individual differences (Utibe & Agwagah, 2016).

Okechukwu (2010) conducted a research on effect of geo-board on Senior Secondary School students' achievement in geometry in schools in Enugu State. The findings were that geo-board facilitates student's achievement more than conventional approach and there was no interaction between gender and instructional materials.

Achor, (2012) conducted a research on improving Senior Secondary Students' achievement in Geometry. The results obtain using ANCOVA to test the hypothesis show that there was no significant difference in the mean achievement scores of students taught geometry using geo-board and those taught without the use of geo-board. There was no significant difference in the mean achievement scores of male and female students taught using geo-board. That sex was not a significant factor in student's achievement in geometry when taught using geoboard.

Also, a research conducted by Hannafin (2013), on the use of geo-board as instructional material to improve teaching and learning at University of Connecticut. The researcher uses ANCOVA to test the hypothesis, the geoboard group scored only marginally higher than did the Tutorial Group. The interaction was not significant. Finally, the relevance of geometry and subsequent difficulties experienced by students at Junior Secondary Schools in Akwa Ibom State, Nigeria made this study very important to the students, teachers and the parents. The need, therefore, arise to examine the effect of the use of geo-board and charts on Senior Secondary School students' achievement in Essien Udim Local Government Area, Akwa Ibom State.

**Statement of the Problem**

The researchers identified the problem of the students from the analyses of Akwa Ibom State Junior School Certificate Examination scripts from 2018 – 2023, these reports

pointed out that majority of Junior Secondary Schools candidates refrained from answering questions involving geometry at Junior School Certificate Examination. This situation was supported by the earlier work of Agwagah, Utibe and Uko (2011), who stated that little attention is focused on the practical aspect of teaching geometry at Junior School Level of Education**.** Equally, importance is a teacher's perception that mathematics has no instructional materials. As a result, the researchers are prompted to carry out a study on the Effects of use of Geo-board and chart on Students Achievements in geometry in Essien Udim, Akwa Ibom State.

**Purpose of the Study**

The purpose of the study is to investigate the effects of geo-board and charts on students' achievement in mathematics in Essien Udim, Akwa Ibom State, Nigeria. Specifically, the researchers seek to determine:

1. The mean achievement scores of students' in Geometry when taught using geo-board and charts
2. The mean achievement scores of male and female students in Geometry
3. The interaction effect of gender and instructional materials on Students' achievement in geometry.

**Research Questions**

The following research questions guided the study:

1. What is the mean achievement scores of students' in Geometry when taught using geo-board and charts?
2. What is the mean achievement scores of male and female students' in Geometry?
3. What is the interaction effect of gender and instructional materials on Students' achievement in geometry?

**Hypotheses**

The following null hypotheses were formulated and tested at an alpha level of 0.05.

1. There is no significant difference in the mean achievement scores of students' in Geometry when taught using geo-board and charts.
2. There is no significant difference in the mean achievement scores of male and female students' in Geometry.
3. There is no significant interaction effect of gender and instructional materials on Students' achievement in geometry.

**Significance of the Study**

The findings of this study when published would be of great significance to the students, teachers, curriculum planners, parents and sponsors who expects a lot from their children and expect them to perform well in school. This study is based on the social constructivist theory by Jane Piaget. This theory emphasizes that individuals learn when they

actively construct knowledge and understanding through interacting with the materials and others in the class (Babayemi, Utibe & Babalola, 2018). In this study, emphasis is therefore given to interactions rather than cognitive actions of the students.

## METHOD

The study employed a quasi-experimental design, because in this design, participants are not randomly assigned to experimental group (Nworgu, 2015). Pretest and posttest was administered to the groups used for this study. The essence of the two tests is to make sure that whatever difference occurs can be attributed to the effect of the treatment given to the groups. The study was conducted in Essien Udim Local Government Area of Akwa Ibom State, Nigeria. It is located on latitude 5.0554 and longitude 7.7399 and has an elevation of 78m above sea level. It has a population of 229,070 people (population Estimate, NBS, 2011). The populations of the study consist of all the Junior Secondary one mathematics students for 2022/23 academic year. The JSI students were chosen because the topics taught were drawn from the JSI mathematics curriculum 2007. There are 11 public secondary schools with a student's population of 3495 SSI students (LEC, Essien Udim, 2023). A total of 126 students (68 students in geo-board and 58 students in the chart experimental groups) constitute the sample for the study.

A total of two co-educational schools with intact classes of JSI mathematics students were drawn for this study. The intact classes were assigned to the different treatment lesson packages (one with geoboard, the other with chart) according to the purpose of the study. This was to control for errors arising from teacher variables as one teacher handles only one treatment group.

The instrument the researchers used to collect data for the study was Geometry Achievement Test (GAT). It consists of 25 multiple choice questions lettered A – D with only one correct option and three distracters. These test items were drawn from Akwa Ibom State Ministry of Education JSS past questions related to JS1 Mathematics curriculum content in plane geometry. The test was used to gather scores of students that learn Mathematics using geo-board and charts instructional materials. Two lesson packages (one for geo-board and the other for chart teaching group) were prepared by the researchers and used in teaching the students the concept of plane geometry in Mathematics. The contents of the lesson packages were similar but the main difference was in the area of instructional materials used in teaching the students. The teachers while teaching the students keep to the recommended instructional materials required for each group.

The instrument was face validated by four experts, three from the Department of Science Education and one from Research, Measurement and Evaluation from Akwa Ibom State University Ikot Akpaden, Mkpat Enin. The advice of these experts helped in the modification of the instrument and lesson packages content where necessary. The geometry achievement test was subjected to content validation using the table of specification. To further strengthen the validity of the above instrument, the instrument was administered to a trial testing group of 30 students who would not be part of the main subjects for the study but who were found to be equivalent in all respects to the subjects in the study. The use of $KR_{20}$ in assessing the internal consistency of the test yielded a reliability index of 0.79.

At the onset of the study, subjects in both groups were given the pretest. After the administration of the pretest, the regular mathematics class teachers in the various schools taught the students in their respective schools. The experiment was conducted during the normal school hours using the school time-table for classes. The duration for the teaching was two weeks. At the end of the teaching, the teachers then administer the post-test to the subjects in the two groups. The pretest and posttest was the same for both groups except in the design of the question paper. The data collected from the pretest and posttest was analyzed using descriptive statistics and Analysis of Covariance (ANCOVA), using pretest and posttest scores as covariates. All hypotheses will be tested at a 0.05 alpha level of significance.

## RESULTS AND DISCUSSION

**Research Question One:** What is the mean achievement scores of students' in Geometry when taught using geo-board and charts?

**Table 1**: Pretest/Posttest of the mean achievement scores of mathematics students in the concept of Geometry

| Instructional materials | N | Pretest $\bar{x}$ | SD | Posttest $\bar{x}$ | SD | Mean Difference |
|---|---|---|---|---|---|---|
| Geo-board | 68 | 14.14 | 4.20 | 66.97 | 8.71 | 52.83 |
| Chart | 58 | 11.56 | 3.18 | 59.72 | 9.91. | 48.16. |

The result presented in Table 1 shows the pretest and posttest mean score of the mean achievement scores of students' in Geometry when taught using geo-board and charts in pubic secondary schools in Essien Udim local government area. From the result, the group

exposed to geo-board instructional materials had a pretest mean score on the concept of motion of (- = 14.14, SD = 4.20) and a posttest mean score of ($\bar{x}$ = 66.97, SD = 9.91). The mean difference was 52.83. On the other hand, the chart instructional materials group had a pretest mean score of ($\bar{x}$ = 11.56, SD = 3.18) and a posttest mean score of ($\bar{x}$ = 59.72, SD = 9.92). The mean difference was 48.16. The mean difference of 52.83 and 48.16 for those exposed to geo-board and charts instructional materials groups respectively shows that geo-board instructional materials was more effective in increasing the mean achievement scores of students in the concept of geometry in mathematics more that the charts instructional materials.

**Research Question Two:** What is the mean achievement scores of male and female students' in Geometry?

**Table 2**: Pretest/Posttest of the mean achievement scores of male and female mathematics students in the concept of Geometry

| Gender | N | Pretest | | Posttest | | Mean Difference |
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | |
|---|---|---|---|---|---|---|
| Male | 73 | 14.14 | 3.04 | 68.92 | 6.80 | 54.14 |
| Female | 53 | 12.86 | 4.19 | 56.72 | 9.55 | 43.86 |

The analysis of the result presented in Table 2 shows the pretest and posttest mean scores of the male and female students' in Geometry. The result showed that the male students had a pretest mean achievement score of ($\bar{x}$ = 14.14, SD = 3.04) and a posttest mean score of ($\bar{x}$ = 68.92, SD = 5.80). The mean difference was 54.14. The result also showed that the female students had a pretest mean achievement score of ($\bar{x}$ = 12.86, SD = 3.19 and a posttest mean score of ($\bar{x}$ = 56.72, SD = 9.55). The mean difference was 45.86. From the result, the mean difference of 54.14 and 43.86 for male and female students respectively showed that the mean achievement scores of male students on the concept of geometry in mathematics increased during the treatment period more than their female counterparts.

**Research Question Three:** What is the interaction effect of gender and instructional materials on Students' achievement in geometry?

**Table 3**: Interaction effect of instructional materials and gender on students` achievement scores in concept of geometry

| Instructional Materials | Gender | N | Pretest | | Posttest | | Gain Score |
| | | | $\overline{x}$ | SD | $\overline{x}$ | SD | |
|---|---|---|---|---|---|---|---|
| Geo-board | Male | 38 | 14.24 | 3.23 | 69.84 | 5.28 | 55.60 |
| | Female | 30 | 11.64 | 4.02 | 60.00 | 9.15 | 50.36 |
| Chart | Male | 35 | 12.04 | 2.18 | 68.00 | 4.90 | 55.96 |
| | Female | 23 | 10.08 | 3.00 | 53.44 | 6.16 | 42.36 |

Table 3 shows the pretest and posttest mean scores of the interaction effect of instructional materials and gender on students` achievement in the concept of geometry in mathematics. The result showed that the male students in the geo-board group had higher mean difference of 55.60 as compared to the female students who had 50.36. This means that geo-board instructional materials proved to be more effective in increasing the mean achievement scores of male students in the concept of geometry in mathematics more than their female counterparts. Furthermore, male students under the chart instructional materials group had higher mean difference of 55.96 as against 42.36 for the female students. This implies that geo-board instructional materials proved to be more effective in increasing the mean achievement scores of male students more than the female students. The result showed that the instructional materials generally increased the mean achievement scores of male students more than the female students. To test for the significant interaction effect of instructional materials and gender on the mean achievement scores of students in the concept of geometry in mathematics, see hypothesis three.

**Hypothesis One:** There is no significant difference in the mean achievement scores of students' in Geometry when taught using geo-board and charts.

**Table 4:** Analysis of Covariance (ANCOVA) of the mean achievement scores of mathematics students in the concept of geometry

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 5083.172[a] | 6 | 635.396 | 9.152 | .000 | .346 |
| Intercept | 17520.962 | 1 | 17520.962 | 252.376 | .000 | .735 |
| Pretest | 759.130 | 1 | 759.130 | 10.935 | .001 | .107 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Instructional Materials | 527.527 | 1 | 527.527 | 7.599 | .006 | .097 |
| Gender | 2021.031 | 1 | 2021.031 | 19.111 | .000 | .242 |
| Instructional Materials* Gender | 2164.358 | 1 | 2164.358 | 23.088 | .032 | .383 |
| Error | 6317.588 | 116 | 69.424 | | | |
| Total | 418700.000 | 126 | | | | |
| Corrected Total | 11400.760 | 125 | | | | |

a. R Squared = .346 (Adjusted R Squared = .301)

The result on Table 4 shows the ANCOVA of the mean achievement scores of students' in Geometry when taught using geo-board and charts in Essien Udim local government area. The result shows that an f-ratio of ($F$ (1, 116) = 7.599, $p < 0.05$, $\eta^2_p$ = 0.077) was obtained. Since the associated probability value of 0.006 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there is a significant difference between the mean achievement scores of students' in Geometry when taught using geo-board and charts. Geo-board significantly increased the mean achievement scores of mathematics students in the concept of geometry than the chart instructional material. The result further showed an effect size of ($\eta^2_p$ = 0.097), indicating that 9.7% variance of the increase in the mean achievement scores of students in the concept of geometry in mathematics was due to the treatments.

**Hypothesis Two:** There is no significant difference in the mean achievement scores of male and female students' in Geometry.

The result on Table 4 shows the ANCOVA of the influence of gender on the mean achievement scores of students in the concept of geometry in mathematics. The result showed that an f-ratio of ($F$(1, 122) = 19.111, $p < 0.05$, $\eta^2_p$ = 0.242) was obtained. Since the associated probability value of 0.000 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there was a significant difference between the mean achievement scores of male and female students in the concept of geometry in mathematics. The result further showed an effect size of ($\eta^2_p$ = 0.242), which means that only 24.2% variance of the increase in the mean achievement scores of students in the concept of geometry in mathematics was due to the influence of gender.

**Hypothesis Three** There is no significant interaction effect of gender and instructional materials on Students' achievement in geometry.

The result on Table 4 shows the ANCOVA of the interaction effect of instructional materials and gender on the mean achievement scores of students in the concept of geometry in mathematics. The result shows that an f-ratio ($F(1, 122) = 23.088$ ($p > 0.032$, $\eta^2_p = 0.383$) was obtained. Since the associated probability value of 0.032 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there was a significant interaction effect of gender and instructional materials in the concept of geometry in mathematics. The result further showed an effect size of ($\eta^2_p = 0.383$), which means that only 38.3% variance of the increase in the mean achievement scores of students in the concept of geometry in mathematics was due to the interaction effect of instructional materials and gender.

The findings of this study in Table 4 shows that there is a significant difference between the mean achievement scores of students' in Geometry when taught using geo-board and charts.in favour of students using geo-board. This implies that hypothesis one is rejected. The initial differences in the mean achievement score between those taught using geo-board and charts instructional materials was found to be significant when subjected to hypothesis testing. The finding of this study collaborated with the work of Hannafin (2013) which investigate the use of geo-board as instructional material to improve teaching and learning in mathematics in University of Connecticut. The reason for this results is related to the fact the use of geo-board is more practical and in line with the theory supporting the study.

The findings of this study in Table 4 also shows that there was a significant difference between the mean achievement scores of male and female students in the concept of geometry using geo-board and charts instructional materials in favour of male students. This implies that hypothesis two is rejected. The initial differences in the mean achievement score between male and female students exposed to geo-board and charts instructional materials was found to be significant in favour of male when subjected to hypothesis testing. The findings of this study contradict the position of Utibe & Agwagah (2016) in a study on creating entrepreneurs using physics and mathematics: Implications for economic development in South-South Nigeria. The reason for this result is related to the fact the use of geo-board practice in this study favours the male students more than the female students.

The findings of this study in Table 4 also show that there was a significant interaction effect of gender and instructional materials in the concept of geometry in mathematics. This implies that hypothesis three is rejected.

## CONCLUSION

Both geo-board and charts instructional materials improved students' achievement in the concept of geometry in mathematics, but students in geo-board group outperformed their counterparts in chart instructional materials. Students could be taught using both types of instructional materials. It was discovered that male students significantly achieved more than the female students in the concept of geometry in mathematics. Teacher of mathematics needs to have good understanding of these instructional materials so as to use them maximizing both male and female students' achievement. In order not to disadvantage female students in the class, it is pertinent that other forms of instructional materials that will make female students perform at maximum should be explored.

## RECOMMENDATIONS

Based on the results of the study, the following recommendations were made:

1. Due to the effectiveness of geo-board over chart instructional materials on students` achievement in the concept of geometry in mathematics it is recommended for use by the teachers in teaching mathematics.

2. Since geo-board and charts doesn't provide equal opportunities for both male and female students, a better instructional material(s) should be research into to provide an improved achievement for the female students in mathematics.

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