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# USE OF FORMATIVE ASSESSMENT WITH BIG DATA ANALYTICS ON SENIOR SECONDARY SCHOOL STUDENTS' MATHEMATICS ACHIEVEMENT IN ENUGU STATE, NIGERIA

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***KEYWORDS:***
*Formative assessment,* big data analytics, students, mathematics, achievement

**Abstract**

*Mathematics as a core subject for all the students at the secondary schools in Nigeria plays fundamental role in enhancement of growth and development of the nation. A shortfall in the knowledge of the students in the subject due to method of teaching/assessment will generates unreliable data and poor students achievement, hence, this study assessed use of formative assessment with big data analytics on senior secondary school students' Mathematics achievement in Enugu State, Nigeria. Two research questions and its corresponding hypotheses using a quasi-experimental research design which involves the non-randomized pretest, posttest, post posttest, control group design. The population of the study consisted of all 24,545, Government senior secondary schools two (SS II) students from 292 schools and 125 SS II Mathematics students selected from two schools were used as a sample size of the study. Mathematics Achievement Test (MAT) was used as instrument for data collection which contained 30 items and it was subjected to expert's judgment, yielded 0.83 validity index, $KR_{-21}$ formula was used which gave r0.82 reliability index. MAT was administered and the data collected were analyses using disruptive and*



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*inferential statistics. Findings revealed that students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group and male and female students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group. Based on the findings of this study, it was recommended that, the teachers of Mathematics should use formative assessment with big data analytics strategy to assess/teach will enhance the understanding and long retentive capacity of both male and female students among others.*

**Introduction**

Mathematics is one of the most important subjects taught in all levels of secondary education in Nigeria. Mathematics is a subject of numbers, shapes, data, measurements and also logical activities. It has a huge scope in every field of our life, such as medicine, engineering, finance, natural science, economics, and it is an area of knowledge that includes such topics as numbers, formulas and related structures, shapes and the spaces in which they are contained, and quantities and their changes. Mathematics is the science that deals with the logic of shape, quantity and arrangement (Kareem, 2013). Mathematics is seen as one of the core subjects in Nigerian secondary school curriculum. Because of its significance, more students enrolled for Mathematics in the Senior Secondary School Certificate Examination (SSCE) to enhanced their educational aspirations into tertiary institutions (WAE, 2018). Mathematics helps the man to give exact interpretation to his ideas and conclusions

In spite of the importance and popularity of Mathematics among Nigerian students, performance at senior secondary school level has been poor (Ahmad, 2018). The reports attributed the cause of students' poor performance to lack of knowledge of subject matter, non commitment and poor strategy on the part of teachers. Alubaleze (2014) posited that poor method of teaching like the conventional or lecture method is the root factor to students' poor achievement and retention in Mathematics. Poor teaching strategies adopted by teachers at senior secondary school level in Nigeria have been identified as one of the major factors contributing to poor performance of students in Mathematics (Ahmed, & Abimbola, 2011, Kareem, 2013, Umar, 2011).

However, conventional teaching method is classroom-based and consists of teaching and direct instructions conducted by the teacher. This teacher-centered

method emphasizes learning through the teacher's guidance at all times. Students are expected to listen to lectures and learn from them. The teacher often talks at the students instead of encouraging them to interact, ask questions, or make them understand the lesson thoroughly. Most classes involve rote learning, where students depend on memorization without having a complete understanding of the subject. Just passing the tests, consisting of descriptions, matching, and other forms of indicators, is all that matters to complete the curriculum (Adegoke, 2011, Umar , 2011) . The persistent use of this method makes students passive rather than active learners. It does not promote insightful learning and long–term retention of some abstract concepts in Mathematics (Ahmed & Abimbola, 2011, Kareem, 2013). According to Umar, ( 2011), Undigwomen, (2014) the implication of this method teaching makes the teacher active and learner passive listener in the teaching and learning environment, with the poor achievement of students in public examinations coupled with societal vices prevalent in the society, especially among the youths, there is need for instruction to be more effective to enhance students' achievement and retention in Mathematics as well as discipline leading to values that will make individuals lives as good citizen when there good achievement at Senior Secondary School Certificate Examination.

Furthermore, the results of the Senior Secondary School Certificate Examination May/June WAEC, 2021Mathematics students in Nigeria revealed an 'unprecedented' success rate in the examination with a total of 1,274,784 candidates, representing 81.7 per cent of the total 1,560,261 candidates that sat the examination who secured credit pass in five subjects including English and Mathematics., Six Hundred and Thirty Thousand, One Hundred and Thirty Eight (630,138) that is 49.43% were male candidates, while Six Hundred and Forty Four Thousand, Six Hundred and Forty Six (644,646) that is 50.57% were female candidates(WAEC, 2021). It is argued that gender disparities have influence on students' academic performance (Egbuna, 2007). There is an acknowledged issue of female students' under-achievement when compared with their male counterparts apparently under equivalent conditions. The controversy over which sex achieve better in academics is evidenced in some studies. Okafor, (2016) asserted that female achieve better than male in general academics. Female achievement in science and attitude to science and mathematics are inferior to those of their male counter parts; whereas females perform better in liberal Arts. Investigations in many areas of liberal arts and social sciences related with

assessing academic attainment of students have confirmed males' aggregate underachievement compared to females (Omoruyi, & Omofonmuan, 2015). This could be due to conventional teaching method by the teachers of Mathematics and failure to introduce formative assessment strategy.

Formative assessment involves a continuous way of checks and balances in the teaching learning processes. The method allows teachers to frequently check their learners' progress and the effectiveness of their own practice Hannah, George, Elizabeth, Kirsteen, & Ruochen, (2019) thus allowing for self assessment of the student. Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited Black, & Wiliam, 2019). Assessment it is the practical application of measurement and just as all testing could be subsumed under assessment, so could all assessment be subsumed under measurement (Anikweze, 2015). This necessitated formative assessments; formative assessments give in-process feedback about what students are or are not learning so instructional approaches, teaching materials, and academic support can be modified to the students' needs. Because of the additional data students and teachers are better equipped to understand the gap in learning and try new ways of learning prior to a high stakes traditional assessment where teachers often move on from previous topics and continue with new material based on big data.

In the context of formative assessment, big data refers to learner data that is deep and broad (Ugodulunwa, & Anikweze, 2019). Examples of broad data are test and examination scores, while data within individual learners, such as background, behavioural and contextual as well as test/examination scores information are deep data. Thought, big data analytics**,** this refers to the collection of software facilities for reading and manipulating data, computation, conducting statistical analyses and displaying the results. Big data enrich the assessment process by providing continuous diagnostic information on learners' knowledge and related behaviour and promoting learning via targeted feedback. This implies that an online learning platform is required, where a student's learning process, such as contributions to a discussion forum, learning sessions, steps in problem-solving, interactions with learning resources, peers, or teachers, can be continually monitored. Big data and learning analytics, therefore, have great promise in online learning environments because meaningful information across and within learners

provide a strong basis for assessment for improving students' learning. Ugodulunwa and Okolo (2015) findings revealed that formative assessment reduced anxiety level and improved mathematics performance of the students. Similarly, Ugodulunwa, and Anikweze (2019) findings revealed that formative assessment lead to increase positive attitude and improved Social Studies achievement of the students, and Galle and Kukwi (2020) finding also revealed that formative assessment reduced anxiety level and significantly increased econometrics academic achievement of the male and female students. Mehmood ( 2012) findings revealed that formative classroom assessment had effect on the students' academic achievement in favour of the experimental group than conventional group; formative classroom assessment was also found to improve the students' academic achievement as observed in the difference between pre-test and post-test in favour of the post-test; and no significant difference in the scores of male and female exposed to the formative classroom assessment. It is against this background that this study focused on the use of formative assessment with big data analytics on senior secondary school students' mathematics achievement in Enugu State, Nigeria.

**Research Questions**

RQ1. What are the achievement mean scores of students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method?

**RQ2**. What are the achievement mean scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method?

**Research Hypotheses**

**HO1:** There is no significant difference in the achievement mean scores of students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method

**HO2:** There is no significant difference in the achievement mean scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method.

**Material and Methods**

**Design**

The study adopted a quasi-experimental research design which involves the non-randomized pretest, posttest, post posttest, control group design. This was considered suitable because randomization of subjects was not feasible as intact classes constitute the two groups that were used for the study. This is in



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agreement with the view of [28] who postulated that the use of such designs that do not involve randomization is called the quasi-experimental design. The study comprised one experimental group and one conventional group. The experimental group will be exposed to the use of Formative Assessment Package with Big Data, while the control group will be exposed to the use of Conventional Teaching Method. The design is symbolically represented in fig1.

| Group | Achievement | |
|---|---|---|
| Experimental Group | $O_1$ $X_1$ $O_2$ | |
| Control Group | $O_1$ — $O_2$ | |

***Fig1:*** *Illustration of the Design of the* ***Study***

Where:

$O_1$ = Pre-test with Mathematics Achievement Test (MAT)

$O_2$ = Post-test with Mathematics Achievement Test (MAT)

$X_1$ = Treatment (use of Formative Assessment Package with Big Data)

— = Control (use of Conventional Teaching Method)

**Population and Sampling Techniques**

The population of the study consisted of all 24,545, Government senior secondary schools two (SS II) students duly registered in 2021/2022 academic session from 292 secondary schools in Enugu State, Nigeria. The sample for the study comprised 125 SS II Mathematics students intact classes randomly selected from two schools; Model Secondary School, Nsukka and Urban Secondary School, Oji-river, Enugu State, Nigeria. Model Secondary School, Nsukka 65 students (35male, 30female) were exposed to teaching of Mathematics using Formative Assessment Package with Big Data while the Urban Secondary School, Oji-river 60 students (32male, 28female) were exposed to Conventional Teaching Method. The rationale for the selection using simple random sampling to select those two schools within the entire schools was because an experiment of this nature cannot be conducted in the entire state in a single study (Uzoechi, 2015).

**Instrument for Data Collection**

Mathematics Achievement Test (MAT) was developed by the researchers as instrument for data collection. The MAT contained a 30 items Multiple Choice with four options A-D that tested the students' based on six levels of cognitive domain embedded on operational chart using selected topics in Mathematics which

include; *Statistics and Probability*, Quadratic and Simultaneous equations. The selection of these topics is based on the fact that they have often been considered difficult to understand by students and also because of lack of adequate facilities for students' practice. The items were allotted 2 marks each, giving total score of 60 marks. Table of specification was developed to ensure content validity of the covered topics. The shown in table 1 below:

**Table 1: Operational Chart or Table of Specification for Mathematics Achievement Test**

| S/N | Content | Hrs | K(20%) | C(20%) | $A_1$ (20%) | $A_2$ (20%) | S(10%) | E (10%) | Total 100% |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *Statistics and Probability (33%)* | 2 | 2(1,2 ) | 2(3,4 ) | 2(5,6) | 2(7,8 ) | 1(9 ) | 1(10 ) | 10 |
| 2 | Quadratic equation *(33%)* | 2 | 2(11,12 ) | 2(13,14 ) | 2(15,16) | 2(17,18 ) | 1( 19) | 1(20 ) | 10 |
| 3 | Simultaneous equations *(34%)* | 2 | 2(21,22) | 2(23,24) | 2(25,26 ) | 2(27,28 ) | 1(29 ) | 1(30 ) | 10 |
| | *Total Items* | 6 | 6 | 6 | 6 | 6 | 3 | 3 | 30 |

**Key:** K=Knowledge, C= *Comprehension, A1=Application, A2=Analysis, S=Synthesis and E=Evaluation*

**Validity and Reliability of Instrument**

MAT was subjected to two expert's judgment for faced and content validation. An expert from Science, Technology and the other one from Measurement and Evaluation unit, Nasarawa State University, Keffi validated the instrument (MAT) by checking for the appropriateness and relevance of the items in agreement with Bloom taxonomy of educational objective as cited in [30]. The logical consensus of the experts yielded 0.83 validity index. To determine the reliability of the instrument (MAT), $KR_{-21}$ formula was used which gave r0.82 reliability index. $KR_{-21}$ formula was considered appropriate because, is a more general method of estimating internal consistency for instrument composed of dichotomous items that measure reliability for a test with binary variables; that is A, B, C, D. answers that are right or wrong. The reliability result of MAT was compared with the guidelines for interpreting alpha coefficients suggested [31] that "$\alpha \geq 0.9$


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excellent, ≥ 0.8 good, ≥ 0.7 acceptable, ≥ 0.6 questionable, ≥ 0.5 poor, ≤ 0.5unacceptable". Therefore, the results of the reliability enabled the researchers to use the instrument for both pretest and posttest, since the correlation was considered high and significant.

**Procedure for Data Collection**

Two research assistants were trained by the researchers to assist in teaching and administered MAT. The researchers' assistants are regular Mathematics teachers in the respective school with years of teaching experience and both hold Second Degree in Mathematics Education, the researchers monitor their activities. A week training programme was organized with the research assistants. The training programme was to acquaint the research assistants with how to use MAT to applied Formative Assessment Package with Big Data Analytics with the experimental group. The following features were addressed during the training, the objectives and how the test administration, scoring of tests papers were discussed and research assistants were given the opportunity to demonstrate the use of the packages in teaching before the commencement of the treatment.

The training ensured that the teaching was comparability, applying the same teaching skills with little or no variation in their teaching effectiveness. Items for the tests lasted for one hour forty five minutes. During the period of testing, the researchers and research assistants ensured that the students were not cheating. Test items were given to the students as a pretest for the purpose of ascertaining the prior knowledge of the students before the treatment was given to the experimental groups. Students were required to encircle the correct option out of five alternatives (A, B, C, D E) provided for each question on the answer sheet. After the time allocated for the test, the scripts were collected marked and scored using a marking scheme.

The experimental group students were taught using Formative Assessment Package with Big Data Analytics while control group students were taught using Conventional Teaching Method covering twenty (20) lessons taught within four weeks (5 time lessons in every week). At the end of the four weeks of teaching the posttest on MAT was administered to both the experimental and control groups. The post post-test took placed after two weeks from the treatment. The pretest and posttest results were compared to obtain the achievement mean gain scores and later post post-test scores was compared with the previous scores to determined achievement gain of the experimental and conventional groups. Means, standard deviation were used for answering research question and ANCOVA using IBM SPSS version 23 was used for testing of hypotheses at the 0.05 level of significant. The results are presented in below tables.


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**Results**

**Research Questions/ Hypotheses**

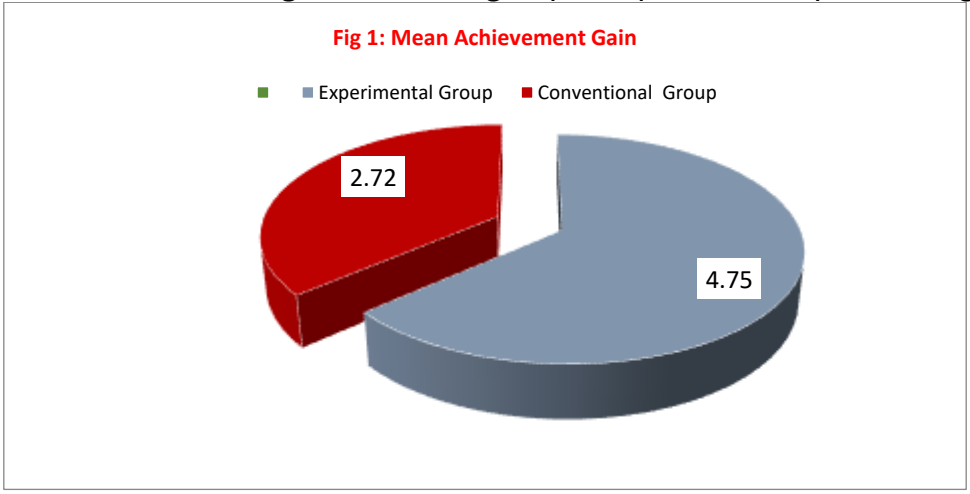
**Research Question 1:** What are the achievement mean scores of students taught Mathematics using formative assessment with big data analytics and those taught using Conventional Teaching Method?

**Table 2: Means and Standard Deviations for Experimental and Control Group**

| Treatment Groups | No of Cases | Pre-test | | Post-test | | Achievement Gain |
|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | |
| **Experimental Group** | 65 | 23.43 | 4.84 | 28.18 | 5.30 | 4.75 |
| **Conventional Group** | 60 | 21.14 | 4.59 | 23.86 | 4.88 | 2.72 |

***Source:*** *Researchers field work (2022)*

Table 2 shows means and standard deviations for difference in mean achievement scores of students taught Mathematics using formative assessment with big data analytics and those taught using Conventional Teaching Method. The variation in the pre-test and post-test mean scores for experimental group is 4.75 and 2.72 for Conventional group as mean achievement gains, that is (EG=4.75>CG=2.72). This is an indication that students taught Mathematics using formative assessment with big data analytics gains higher achievement gains in Mathematics related concepts than their counterpart students in conventional group. Graphically, the means achievement gain scores for groups are presented in pie-chart fig 1 below.




The result of research question one in Table 2 was confirmed by testing Ho1**:** there is no significant difference in the achievement means scores of students taught Mathematics using formative assessment with big data analytics and those taught



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using conventional teaching method at the 0.05 level of significant using ANCOVA and the  is shows in Table 3.

**Table 3: ANCOVA Results for Significant Difference in Mean Scores of Students in Experimental and Control Group**

| Source of Variation | Type III Sum of Squares | Df | Mean Square | $F_{cal}$ | P-value | Sig |
|---|---|---|---|---|---|---|
| Corrected model | 44304.53 | 2 | 22152.27 | 189.028* | .000 | P<0.05 |
| Intercept | 620.99 | 1 | 253.17 | 44.716* | .000 | P<0.05 |
| Pre-MAT scores | 6462.22 | 1 | 2594.72 | 116.15* | .001 | P<0.05 |
| Groups | 41308.84 | 1 | 168.23 | 346.894* | .001 | P<0.05 |
| Error | 5953.29 | 123 | 46.26 | | | |
| Total | 344586.00 | 125 | | | | |
| Corrected Total | 50257.82 | 124 | | | | |

***Source:*** *Researchers field work (2022)*

The result presented in Table 3 shows the significant difference in the achievement means scores of students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method at df=2, 123, $F_{cal}$ =346.894, P-value=.001 (p<0.05). This suggested a statistically significant difference in the mean achievement scores of students' taught Mathematics in experimental and than their counterpart students in conventional group. Thus, the null hypothesis one was not retained. Hence, there was a difference in the achievement means scores of students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method. This implied that students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group.

**Research Question 2:** What are the achievement mean scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method?

**Table 4: Means and Standard Deviations for Male and Female Students in Experimental and Control Group**

| Treatment Groups | Gender | No of Cases | Pre-test | | Post-test | | Mean Achievement Gain |
|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Mean | SD | |
| **Experimental Group** | Male | 35 | 13.43 | 3.66 | 16.81 | 4.10 | 3.38 |



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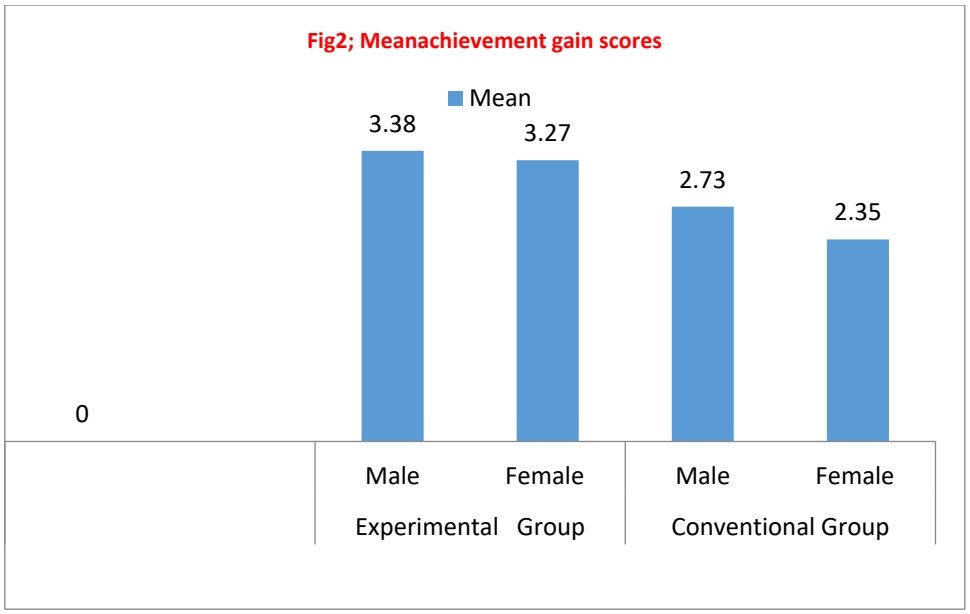
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Female | 30 | 13.13 | 3.62 | 16.40 | 4.04 | 3.27 |
| **Conventional Group** | Male | 32 | 12.14 | 3.48 | 14.87 | 3.85 | 2.73 |
| | Female | 28 | 12.12 | 3.48 | 14.47 | 3.80 | 2.35 |

***Source:*** *Researchers field work (2022)*

Table 4 shows means and standard deviations for difference in mean achievement scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using Conventional Teaching Method. The variation in the pre-test and post-test mean scores for experimental group male and female students had the highest mean achievement gain 3.38 for male and 3.27 for the female while in the conventional group had 2.73 for male and 2.35 for the female respectively. This is indicated that male and female students taught Mathematics using formative assessment with big data analytics gains higher achievement gains in Mathematics related concepts than their counterpart students in conventional group. Graphically, the means achievement gain scores for groups are presented in bar-chart fig 2.




The result of research question two in Table 4 was confirmed by testing Ho2**:** there is no significant difference in the achievement means scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method at the 0.05 level of significant using ANCOVA and the is shows in Table 5.



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**Table 5: ANCOVA Results for Significant Difference in Mean Scores of Male and Female Students in Experimental and Control Group**

| Source of Variation | Type III Sum of Squares | Df | Mean Square | $F_{cal}$ | P-value | Sig |
|---|---|---|---|---|---|---|
| Corrected model | 44304.53 | 4 | 22152.27 | 189.028* | .001 | P<0.05 |
| Intercept | 620.99 | 1 | 253.17 | 44.16* | .001 | P<0.05 |
| Pre-MAT scores | 6462.22 | 1 | 2594.72 | 116.15* | .001 | P<0.05 |
| Groups | 41308.84 | 1 | 168.23 | 346.694* | .001 | P<0.05 |
| Error | 5953.29 | 121 | 46.26 | | | |
| Total | 344586.00 | 125 | | | | |
| Corrected Total | 50257.82 | 124 | | | | |

***Source:*** *Researchers field work (2022)*

The result presented in Table 5 shows the significant difference in the achievement means scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method at df=2, 121, $F_{cal}$ =346.694, P-value=.001 (p<0.05). This suggested a statistically significant difference in the mean achievement scores of male and female students' taught Mathematics in experimental and than their counterpart students in conventional group. Thus, the null hypothesis two was not retained. Hence, there was a difference in the achievement means scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method. This implied that male and female students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group.

**Discussion**

The result in Table 2 shows means and standard deviations for difference in mean achievement scores of students taught Mathematics using formative assessment with big data analytics and those taught using Conventional Teaching Method. The variation in the pre-test and post-test mean scores for experimental group is 4.75 and 2.72 for Conventional group as mean achievement gains, that is


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(EG=4.75>CG=2.72). This is an indication that students taught Mathematics using formative assessment with big data analytics gains higher achievement gains in Mathematics related concepts than their counterpart students in conventional group. Drawing inference from null hypothesis one in Table 3 revealed a statistically significant difference in the mean achievement scores of students' taught Mathematics in experimental and than their counterpart students in conventional group. Thus, the null hypothesis one was not retained. Hence, there was a difference in the achievement means scores of students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method. This implied that students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group. This finding is in agreement with that of Galle and Kukwi (2020), Ugodulunwa and Okolo, ( 2015) findings revealed that formative assessment reduced anxiety level and improved mathematics performance of the students.

Lastly, finding from Table 4 shows means and standard deviations for difference in mean achievement scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using Conventional Teaching Method. The variation in the pre-test and post-test mean scores for experimental group male and female students had the highest mean achievement gain 3.38 for male and 3.27 for the female while in the conventional group had 2.73 for male and 2.35 for the female respectively. This is indicated that male and female students taught Mathematics using formative assessment with big data analytics gains higher achievement gains in Mathematics related concepts than their counterpart students in conventional group. Drawing inference from null hypothesis two in Table 5 showed a statistically significant difference in the mean achievement scores of male and female students' taught Mathematics in experimental and than their counterpart students in conventional group. Thus, the null hypothesis two was not retained. Hence, there was a difference in the achievement means scores of male and female students taught Mathematics using formative assessment with big data analytics and those taught using conventional teaching method. This implied that male and female students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group. This finding is corroborated with that of Mehmood, (2012) revealed that formative classroom assessment had effect on male and female students'


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academic achievement in favour of the experimental group than conventional group; formative classroom assessment was also found to improve the students' academic achievement as observed in the difference between pre-test and post-test in favour of the post-test; and no significant difference in the scores of male and female exposed to the formative classroom assessment. In line with the finings above Ugodulunwa and Anikweze (2019) findings revealed that formative assessment lead to increase positive attitude and improved Social Studies achievement of the students.

**Conclusion**

This study was design to established the effectiveness of formative assessment with big data analytics on senior secondary school students' mathematics achievement thereby resolve the problems associating students achievement in mathematics. The findings of the revealed students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group and male and female students taught Mathematics using formative assessment with big data analytics achievement higher than their counterpart students in conventional group.

**Recommendations**

Based on the findings of this study, the following recommendations are made:

1. That, the teachers of Mathematics should use formative assessment with big data analytics strategy to assess/teach will enhance the understanding and long retentive capacity of both male and female students.
2. That, Enugu State ministry of education should consider incorporating the effectiveness of formative assessment with big data analytics strategy into the teaching/learning of Mathematics
3. That, the Nigerian Educational Research and Development Council (NERDC) should consider incorporating the effectiveness of formative assessment with big data analytics strategy into the teaching of Mathematics.

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