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# Enhancing Pupils' Knowledge of Mathematical Concepts through Game and Poem

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***Abstract:*** *The study investigated the effects of game and poem enhanced instruction on pupils' knowledge of mathematics concepts in mathematics (Fractions and decimals, Volume of, cylinder; triangular prisms and sphere; Capacity and Weight). A total of 344 pupils from twelve (12) public primary schools of Ogbia and Yenagoa Local Government Areas of Bayelsa State, Nigeria were involved in the study. A pretest-posttest control group quasi-experimental design was adopted in the research. The moderating effects of gender were also examined on the independent and dependent variables. Using ANCOVA statistics, the results revealed that pupils exposed to game and poem enhanced instruction have better mean score in knowledge of mathematics concepts than the control groups. Poem was found to be more effective in improving pupils' knowledge of mathematics concepts than game and a non-significant gender difference existed in the mean scores in knowledge of mathematics concepts. There was no significant interaction effect of gender on pupils' knowledge of mathematics concepts. The implication of the findings was discussed and appropriate recommendations were made.*

***Key Words:*** *Game and Poem instructional methods, Pupils' mathematical concepts*

## I. Introduction

The knowledge of mathematics concepts is the main outcome to the extent which a student understand the language of mathematics in any mathematics instruction process. Mathematics concepts are the mathematics words, principles, symbols, formulae and expressions understood in the context of mathematics. In other words, it is the language of mathematics. The knowledge of mathematical concepts is prerequisite for meaningful understanding of mathematics instruction. The ability of students to use mathematical operations to simplify or solve problems depends on a good grasp of the language of mathematics (Akinsola,2005; Obioma, 2005; Gershon, Guwal and Awuya, 2008). Kwok (2009) opines that failure of many children to understand basic mathematics concepts at a very early stage makes them to fare poorly in mathematics. Also, Hogan (2005) states that the main objective of mathematics learning at the primary school level is to develop in the pupils the power of reason, power to solve problem and to find responses that are novel to their experiences. This is dependent on pupils' knowledge and understanding of mathematics concepts and their meaning. It becomes necessary to look for interventions that could be manipulated in order to find their effects on pupils' knowledge of mathematics concepts.

Effective activities recommended for the primary school level include the use of games to enhance greater understanding of concepts (Aremu, 1998; Agwagah, 2001; Akinsola and Animasahun, 2007), creating a creative corner for less capable pupils in Mathematics who may be good in art or writing which include activities such as poetry or stories about mathematical situations and geometric drawings (Ojo, 2008; Albool, 2012). Iji (2007) also recommends to teachers to exhibit poems at the primary school level. Akinsola (2000) found out that students who are provided with adequate opportunities for manipulation of materials accompanied by verbalization of materials as well as conceptualization by means of discovery understand science and mathematics better than those who are not exposed to such. It becomes pertinent for the researcher to determine the effects of poems and games enhanced mathematics instruction on pupils' knowledge of mathematics concepts at the primary school level.

Poetry has vital roles to play in children learning. It is used an advance organizer which is based on Ausubel verbal meaningful learning (1963).The use of poems involves the construction of images for appreciating mathematics. Again, the poems are verbal presentation of the mathematics concepts to be learned. Furthermore, verbal meaningful learning involves speech, reading and writing (Cooper, 2009). The use of poetry in teaching involves these key aspects of learning.

Owen (2010) states that memorizing poetry increases child's cognitive ability, for poems present language in more ordered and rhythmical ways than prose. These techniques increase a child's ability to reason, imagine, think, argue and experience the world in sensory and aesthetic ways. She further states that, through memorization of poetry, a child's mental capacity is exercised and thus increases in flexibility and strength.

Poetry offer mathematics students new means to explore the recondite realm of abstract mathematical concepts, improving cognitive understanding and confidence (Bahls, 2009). Mathematics is not just all about calculations; it is beyond calculation (Agwagah, 2008). 'There is a great and growing body of linguistic and visual metaphors that constitute a healthy understanding of mathematics in which things called fields, rings, bundles and flows play dominant roles; mastery of these concepts often involves creativity more readily expected of a poet than of a scientist' (Bahls, 2009, p.76). Students' cognitive understanding of mathematical terminology and symbolism, and confidence in carrying out computation and other mathematical task are key coordinates of success in learning mathematics (Bahls, 2009).

The other activity that can be used to enhance mathematics instruction is the use of games based on operant conditioning theory which examines the stimulus, the response to the stimulus (a behavior) and the behavior's consequence (Skinner, 1938). The games played are guided by rules. Whenever a pupil plays the game correctly or wrongly, that child is immediately rewarded or punished depending on the rule of the game like the rat in Skinner's box. This leads to behavior modification.

A game is a type of play that follows a set of rules, aims at a definite goal or outcome and involves competition against other players or against barriers imposed by nature of the game (Agwagah, 2001). Game plays vital roles in mathematics instruction. The use of games in teaching mathematics makes students to be actively involved in the daily lessons since they are interested in learning mathematics as game (Abubakar and Bawa, 2006). Games relaxes tension, clear boredom and foster environment where teaching and learning are pleasant, interesting, exciting, stimulating, motivating and at the same time academically rewarding (Kankia, 2008). Azuka (2002) also opines that games provide unique opportunity for integrating the cognitive, affective, and social aspects of learning.

The effect of gender on learning outcomes of mathematics and science related subjects are still a major controversy among educators. This may be as a result of conflicting results from such gender- related studies. Some research results find significant differences in favour of boys, while a few in favour of girls and others are neutral (Onasanya (2008), Shafi and Areelu (2010); Eniayeju (2010); Bawa and Abubakar (2008) and Ebisine (2010) respectively. This inconsistency in the test achievement and interest of boys and girls need to be further investigated in the use of poems and games to enhance mathematics instruction at the primary school level in this study.

**Statement of the Problem**

Mathematics plays a significant role virtually in all activities of man, especially in this modern age of science and technology. Its demand is therefore at a premium position. Yet students' knowledge of mathematics concepts at all levels of education is poor. Available literature shows that students' poor achievement in mathematics and knowledge of mathematics concepts is due to a number of factors, especially on the strategies used for teaching mathematics. The lecture strategy which is predominantly used by the teachers may have contributed too many problems and under achievement in mathematics at various levels of education. Thus, the use of appropriate instructional activities to enhance mathematics instruction in the classroom and improve pupils' knowledge of mathematics concepts in the primary school level becomes necessary. Therefore, this study determines the effects of poems and games enhanced mathematics instruction on pupils' knowledge of mathematics concepts. The study further seeks to determine the moderating effects of gender on the dependent variable.

**Hypotheses**

The following three null hypotheses were tested at 0.05 significant levels.

$H0_1$ There is no significant main effect of treatment on pupils' knowledge of mathematics concepts

$H0_2$There is no significant main effect of gender on pupils' Knowledge of mathematics concepts

$Ho_3$ There is no significant interaction effect of treatment and gender on pupils' knowledge of mathematics concepts

**Scope of the Study**

The study covers primary six pupils in twelve primary schools from Ogbia and Yenagoa Local Government Areas of Bayelsa State. The study investigates the effects of poem and game enhanced mathematics instruction on pupils' achievement, knowledge of mathematics concepts and interest in Mathematics. It also determines the moderating effects of verbal ability and gender on the dependent variables. The concepts selected for the experiment includes fraction and decimal (addition, subtraction, multiplication and division), volume, capacity, weight, 2 and 3- dimensional geometry and word problems. These are perceived difficult topics and areas in the primary mathematics curriculum and listed for primary six pupils in the curriculum.

## II. Methodology

**Research Design**

This study adopted a pretest-posttest, control group quasi-experimental design. The design is schematically represented as:

$E_1$: $0_1$ $X_1$ $0_2$
$E_2$: $0_3$ $X_2$ $0_4$
C: $0_5$ $X_3$ $0_6$

Where:
$0_1$, $0_3$, $0_5$ represents pretest observations for both experimental and control groups.
$0_2$, $0_4$, $0_6$ represents posttest observations for both experimental and control groups.
$X_1$ represents treatment 1; poems enhanced instruction.
$X_2$ represents treatment 2; games enhanced instruction.
$X_3$ represents the modified lecture instruction.

**Selection of Participants**

Two Local Government Areas in Bayelsa State and six schools in each Local Government Areas were purposively selected and assigned for treatment and control groups in this study. The selection of the Local Government Areas was based on the following criteria:
(i) The Local Government Areas must have roadways because of the State's terrain (rivers)
(ii) The Local Government Areas must have at least six (6) public primary schools that have roadways.

The selection of the schools were based on the following criteria: (i) the schools must be public schools (ii) the schools must have experienced teachers who possess teaching qualification and have been teaching mathematics for not less than five years (iii) the teachers must be willing to be involved in the experiment.

Six (6) schools were randomly selected from each Local Government Area; that is a total of twelve (12) schools were used for the study. One intact class of primary six (6) pupils was randomly selected and four (4) schools were assigned to treatment while two (2) schools for control groups for the study. A total of 344 pupils (males=164, females=180) were used.

**Research Instruments**

Four instruments were used in the study. They are:
1. Instructional Guide on Poems Enhanced Instruction (IGPEI).
2. Instructional Guide on Games Enhanced Instruction (IGGEI).
3. Instructional Guide on Modified Lecture Instruction (IGMLI).
4. Pupils' Knowledge of Mathematics Concepts Test (PKMCT).

**Pupils' Knowledge of Mathematics Concepts Test (PKMCT)**

The PKMCT is a twenty (20) items multiple choice test with four options A-D constructed by the researchers to measure pupils' knowledge of mathematics concepts on the topics selected for the study. It is constructed based on what is involved in knowledge of mathematics concepts by Backhouse, Haggarty, Pirie and Stratton (1992), Nnaji (2005) and Binda (2006); that is the words, symbols, principles, expressions, equations, formulae, etc. in mathematics. The section A of PKMCT contains the demographic data of pupils and section B is the twenty (20) items on the content areas.

The modified test of thirty two (32) items by experts were administered to one hundred (100) primary six (6) pupils that were not involved in the real study to determine the discriminating indices for each item and difficulty levels were computed manually by the researchers. The result of the analysis was used to pick twenty (20) items that were neither too difficult nor too easy and this was between 0.4 and 0.6. The twenty (20) items were then re-administered to fifty (50) pupils and a reliability coefficient of 0.81 was obtained using Kuder – Richardson formula 21 (KR-21).

**Research Procedure**

The first week was used for the selection of eligible schools, permission from the school authorities and random assignment of schools into experimental and control groups. Two weeks for training of teachers with the instructional guides (IGPEI, IGGEI and IGMLI). A week was used for the administration of the pretest. Eight weeks were used for the treatment of experimental and control groups PEI, GEI and MLI respectively. A week was used for the administration of posttest by the researcher and research assistants. Lesson plans were provided for each experimental and control groups.

**Method of Data Analysis**

Data collected was analyzed using Analysis of Covariance (ANCOVA). This was used to test the hypotheses using pre-test scores as covariates. Also, the Multiple Classification Analysis (MCA) aspect of the ANCOVA was used to determine the magnitude of performance of the various groups. Scheffe's post-hoc test was also used when significant differences were observed to show the pairs of groups that were significantly different.

## III. Results

**$HO_1$ :** There is no significant main effect of treatment on pupils' knowledge of mathematics concepts.

**Table 2:** One way analysis of covariance (ANCOVA) of post-test scores of pupils' knowledge of mathematics concepts with treatment using pre-test scores as covariates

| Source of variation | Sum of squares | Df | Mean square | F | Sig. | Decision at p < .05 |
|---|---|---|---|---|---|---|
| Covariate pre-test | 2666.557 | 1 | 2666.557 | 1120.515 | 0.000 | |
| Main effects | 1082.531 | 2 | 541.265 | 227.445 | 0.000 | * |
| Model | 3749.088 | 3 | 1249.696 | 525.135 | 0.000 | |
| Residual | 809.119 | 340 | 2.380 | | | |
| Total | 4558.206 | 343 | 13.289 | | | |

* = Significant at 0.05 alpha level; critical F2, 340 = 3.04, N = 344.

The data presented in Table 2 shows that the main effect is significant at F2, 340 =227.445; $p < 0.05$. Hence, the null hypothesis is rejected.

Consequent upon the observed main effect, multiple classification analysis (MCA) was carried out to determine the index of relationship and also to determine the variance of the dependent variable (Pupils' knowledge of mathematics concepts) that is attributable to the influence of the independent variable (treatment) as shows in Table 3.

**Table3:** Multiple classification analysis (MCA) of the post-test scores of pupils' knowledge of mathematics concepts by treatment (instructional methods).

| Grand mean = 12.84 | N | Unadjusted | | Adjusted for independent variables and covariates | |
|---|---|---|---|---|---|
| Variables + Category | | Dev'n | Eta | Dev'n | Beta |
| Treatment (instructional methods) | | | 0.447 | | 0.488 |
| Game enhanced instruction (GEI ) | 116 | 0.436 | | 0.496 | |
| Poem enhanced instruction (PEI ) | 128 | 1.511 | | 1.638 | |
| Modified lecture instruction(MLI ) | 100 | -2.440 | | -2.671 | |
| Multiple R = 0.907. | | | | | |
| Multiple R-squared = 0.822 | | | | | |

The data in Table 3 shows that the deviation of the adjusted post-test scores from the grand mean of 12.84 is 0.496 for pupils' exposed to (GEI). The deviation of the adjusted post-tests scores from the grand mean of 12,84 is 1.638 for pupils' exposed to (PEI), while the deviation of the adjusted post-tests scores from the grand mean of 12.84 is -2.671 for pupils' exposed to (MLI). This implies that pupils' exposed to (PEI) were significantly better than those exposed to both (GEI) and (MLI) in their knowledge of mathematics concepts. To determine the order of effectiveness of treatment and the direction of significance, the post-test scores were subjected to Scheffe's multiple comparison test for post hoc analysis as observes in Table 4.

**Table4:** Scheffe's post hoc pairwise comparison analysis of treatment and pupils' knowledge of mathematics concepts.

| Treatment | N | Mean | GEI | PEI | MLI |
|---|---|---|---|---|---|
| GEI | 116 | 13.28 | | * | * |
| PEI | 128 | 14.35 | * | | * |
| MLI | 100 | 10.40 | * | * | |

Data in Table 4 shows that on pupils' knowledge of mathematics concepts a comparison of pupils' exposed to GEI and PEI had a significant difference. Again it is also noted that a significant difference exist between pupils' exposed to GEI and MLI, similarly, a significant difference exist between pupils' exposed to PEI and MLI. This simply means that the three groups differ in their mean scores on pupils' knowledge of mathematics concepts. This further implies that all the possible pairs therefore contributed to the significant effect obtained on pupils' knowledge of mathematics concepts.

**$HO_2$:** There is no significant main effect of gender on pupils' knowledge of mathematics concepts.

**Table 5:** One way analysis of covariance (ANCOVA) of post-test scores of pupils' knowledge of mathematics concepts with gender using pre-test scores as covariates

| Source of variation | Sum of squares | df | Mean square | F | Sig. | Decision at p < .05 |
|---|---|---|---|---|---|---|
| Covariate pre-test | 2666.575 | 1 | 2666.575 | 483.048 | 0.000 | |
| Main effects | 9.237 | 1 | 9.237 | 1.673 | 0.197 | NS |
| Model | 2675.794 | 2 | 1337.897 | 242.361 | 0.000 | |
| Residual | 1882.412 | 341 | 5.520 | | | |
| Total | 4558.206 | 343 | 13.289 | | | |

NS = Not Significant at 0.05 alpha level; critical F1, 341 = 3.89, N = 344.

The data presented in Table 5 indicates that the main effect is not significant at F 1, 341 = 0.197; p > 0.05. Therefore, the null hypothesis which states that there is no significant main effect of gender on pupils' knowledge of mathematics concepts is retained. This simply means that gender has no main effect on the pupils' knowledge of mathematics concepts.

**$HO_3$:** There is no significant interaction effect of treatment and gender on pupils' knowledge of mathematics concepts.

**Table 6:** Two way analysis of covariance (ANCOVA) of post-test scores of pupils 'Knowledge of mathematics concepts with treatment and gender using pre-test scores as covariates

| Source of variation | Sum of squares | Df | Mean square | F | Sig. | Decision at p < .05 |
|---|---|---|---|---|---|---|
| Covariate pre-test | 2666.557 | 1 | 2666.557 | 1148.643 | 0.000 | |
| Main effects(combined ) | 1103.999 | 3 | 367.980 | 158.511 | 0.000 | |
| Treatment | 1082.531 | 2 | 541.265 | 233.155 | 0.000 | |
| Gender | 21.409 | 1 | 21.409 | 9.222 | 0.003 | |
| 2-Way interactions treatment * gender | | | | | | |
| Model | 5.370 | 2 | 2.685 | 1.157 | 0.316 | NS |
| Residual | 3775.866 | 6 | 629.311 | 271.081 | 0.000 | |
| Total | 782.340 | 337 | 2.321 | | | |
| | 4558.206 | 343 | 13.289 | | | |

NS = Not Significant at 0.05 alpha level; critical F2, 337 = 3.04, N = 344.

Table 6 shows that the interaction effect of treatment and gender is not significant at F 2, 337 =1.157; p > 0.05. Hence, the null hypothesis which states that there is no significant interaction effect of treatment and gender on pupils' knowledge of mathematics concepts is retained. This implies that treatment and gender has no interaction effect on the pupils' knowledge of mathematics concepts.

## IV. Discussion, Conclusion And Recommendations

**Discussion**

**Effect of Treatment on Pupils' Knowledge of Mathematics Concepts.**

The findings revealed that pupils exposed to GEI and PEI had a significant difference in knowledge of mathematics concepts. Also GEI and MLI then PEI and MLI had significant differences. This finding agrees with the assertion of Aremu (1998), Agwagah (2001) and Akinsola & Animasahun, 2007 that the use of game enhances greater understanding of mathematics concepts. Also, the use of poems in developing pupils' knowledge of mathematics concepts confirms the assertion of Bahls (2009) that mastery of mathematical concepts often involves creativity more readily expected of a poet than a scientist. Using poetical metaphors students become more aware of mathematical metaphors and gain deeper understanding to mathematics concepts those metaphors describe.

The advantage PEI had over GEI could be as a result of the opportunity pupils of the PEI group had, that is repeatedly reciting the poems which goes beyond the classroom which help pupils to examine and re-examine mathematical ideas (Bahls 2009). This is in conformity with the statement of St. Cyr (2008) and LeFebvre (2004) that the repetitive nature of poems helps children's memory to learn, expand and build listening skills.

The result further showed that there is no significant main effect of gender on pupils' knowledge of mathematics concepts. The results of the study conform to those of Inekwe (1997) and Galadima and Yusha (2007) who does not find significant differences of gender on pupils' knowledge of mathematics concepts. Both male and female students perform poorly in the test administered on mathematical concepts, principles, terms and symbols.

**Interaction Effect of Treatment and Gender on Pupils' Knowledge of Mathematics Concepts**

The results of the study showed that, there is no significant interaction effect of treatment and gender on pupils' knowledge of mathematics concepts. This implies that treatment is gender insensitive; in other words,

the effect of treatment on pupils' knowledge of mathematics concepts does not vary from male to female. This result gives credence to the findings of Aremu (1998), Olagunju (2001), Imoko and Agwagah (2006), Ekine (2010) and Okigbo and Okeke (2011).It therefore follows that teachers of mathematics should apply game and poem to enhance mathematics instruction irrespective of their gender in order to improve their knowledge of mathematics concepts.

**Educational Implications of the Study**

The study has the following implications for classroom practices.

Teachers of mathematics should be encouraged to use game and poem to enhance their mathematics instruction. These are effective in improving pupils' knowledge of mathematics concepts. The use of poem enhanced instruction is more effective in improving pupils' knowledge of mathematics concepts. Thus, teachers are encouraged to create poems in mathematics concepts which will enhance their understanding and recall of concepts readily. Therefore, games and poems should be constantly used in the mathematics classroom.

A non-significant effect of gender was observed on pupils' knowledge of mathematics concepts. This implies that, game and poem enhanced instruction are good activities in the mathematics classroom for both males and females in developing their knowledge of mathematics concepts

## V. Conclusion

On the basis of the findings in this study, it could be concluded that:

Poem enhanced instruction is most effective in improving pupils' knowledge of mathematics concepts. Therefore, the GEI and PEI are better activities to improve pupils' knowledge of mathematics concepts and should be used in the mathematics classroom.

## VI. Recommendations

Based on the findings of this study, the following recommendations are made. Mathematics teachers should use games and poems to enhance pupils' knowledge of mathematics concepts. Teachers of mathematics should give special attention to the use of poems to enhance pupils' knowledge of mathematics concepts.

Teachers should give both male and female equal opportunity in the classroom for this will raise female students feeling of competence in mathematics.

Mathematical associations and various organs of government saddled with teacher improvement should embark on in-service training for mathematics teachers to equip them with new skills such as game and poem needed for effective learning of mathematics

Mathematics Teacher Educators should introduce pre-service mathematics teachers to embrace innovative strategies like the use of game and poem while implementing the mathematics curriculum.

Curriculum designers should look for means of including the use of game and poem as activities in the curriculum to enhance mathematics instruction.

Authors of mathematics text books should write books on mathematical poems as they have done on mathematical game for easy access and use.

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