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Comparative Effect of Visual and Verbal Algebraic Methods of Teaching Quadratic Equations on Academic Achievement of Secondary School Students in Akamkpa Local Government Area of Cross River State, Nigeria

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Abstract
This research work was designed to determine the comparative effect of visual and verbal algebraic methods of teaching quadratic equation on academic achievement of secondary school students in Akamkpa LGA of Cross River State, Nigeria. Study design was experimental design and involved 160 Senior secondary II (SSII) students drawn by stratified random sampling from four schools, on equal basis. The researchers taught and administered achievement test to both groups. Data generated were subjected to statistical analysis using independent t-test at .05 level of significance. Result shows that students taught quadratic equations with the visual method outperformed their counterpart taught with verbal algebraic method. It was recommended that training of Mathematics teachers on pedagogical skills should emphasize media education and utilization of concrete aids in teaching. Teachers should use visual method in teaching mathematics, and there should be refresher courses for mathematics teachers to keep them abreast with new methods and materials in mathematics education.
Keywords: visual, verbal, algebraic, methods, teaching, quadratic, equations

Introduction
Mathematics is said to be the basis of science. Over the years, the difficulties associated with mathematics and its learning have posed a lot of challenges to educationists. There is however a widespread desire to enlighten students and teachers on the importance of the subject and of the methods of teaching it. It is generally acknowledged that the teaching of mathematics involves a complex and demanding process hence the need to employ methods that could make the process less complex for the teacher and more easily assimilated by the student.

According to Kurnik (2008), a mathematics teacher should introduce students to those facts and form in their thought processes, those mathematical occurrences which are scientifically founded. A mathematics teacher should help the student to discover and learn new mathematical truths using methods that connect the new knowledge with items and materials with which the student is already familiar with. Thus, mathematics teaching has to be such, to enable further broadening and enrichment of content and a natural continuation of the student's knowledge of related mathematical concepts.

For many secondary school students, solving quadratic equation is one of the most conceptually challenging subjects in the curriculum. Within the Nigerian national mathematics curriculum for elementary and secondary level, the teaching and learning of quadratic equations are introduced through factorization, the quadratic formula, and completing the square by using symbolic algorithms. Of these techniques, students typically prefer factorization when the quadratic is obviously factorable. With this technique, students can solve the quadratic equations quickly without paying attention to their structure and conceptual meaning (Sonerhed, 2009). However, as Taylor and Mittag (2001) earlier suggested, the factorization technique is only symbolic in its nature. Since students simply memorize the procedure and formulae to solve quadratic equations, they have little understanding of the meaning of quadratic equations, and do not understand what to do and why.

Although quadratic equations take an important role in secondary school algebra curricula around the world, teaching and learning quadratic equations have not been as well studied as other areas of algebra education research (Vaiyavutjamai & Clement, 2006; Kieran, 2007). Most middle-school teachers consider algebraic manipulations as the most important aspect of school algebra (Lim, 2000; cited in Powell & Fuchs, 2014), yet students often perform these procedural skills without actually comprehending what they are doing (Vaiyavutjamai, 2004).

Visual approach is the method of teaching by which the teacher presents concepts either by the use of concrete or diagrammatic materials. A study by Shabiralyani, Hasan, Hamad and Iqbal (2015) concluded that "using visual aids as a teaching method stimulates thinking and improves learning environment in a classroom." The study showed that effective use of visual aids makes the learning environments less monotonous, makes the learning experience pleasant, and enhances the students personal understanding of the areas of learning. Saunders cited in Amoramo (2015) revealed that visuals are not a universal language but relevant pictures used effectively and generally to understand well and remember easily because they are closely related to the way people see things in everyday life. The use of teaching aids tends to enhance the competence of teachers while making learning to become easier and fun for students. Regarding the effectiveness of visual teaching aid, Agwu and Mbah (2019)

had this to say from a study of Nigerian students, "students taught with visual aids performed better than those taught with the traditional method". Another study by Ibe and Abamuche (2019) similarly concluded that students exposed to lessons with Audio-visual technological contents achieved higher in test scores than those not exposed to audio-visual aids. In yet another Nigerian study involving primary school pupils in this same part of Nigeria as the current study, the researchers found out that pupils were able to understand abstract concepts when taught with instructional aids that include physical objects that can appeal to their senses (Meremikwu, Igiri, Oko & Enukoha, 2012). Enukoha and Meremikwu (2018) further supported this by maintaining that using culturally made aids and pictorially presented objects makes learning of mathematics easier and more memorable than the conventional methods. Amoramo (2015) noted that use of concrete materials in teaching allows the student to acquire mental experience at his own pace even with little additional input by the teacher.

Ross, Morrison and Lowther (2010) are of the opinion that "proficiency in using technology for such contemporary tasks as searching the Internet, creating graphs and illustrations, and communicating through multimedia presentations has become an essential educational outcome, much like being proficient in reading and mathematics". These authors (Ross, Morrison & Lowther, 2010) further asserted that appropriate use of technology could play a valuable role in increasing teachers' effectiveness in organizing and presenting lessons.

The verbal-algebraic approach is the method of teaching by which the teacher dwells much on the oral symbolic expressions. Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding. Mathematical terms, phrases, and symbols are essential in communicating mathematical ideas to students; and becoming knowledgeable and fluent with them is vital for the learning of mathematics (Sanders, 2007, cited by Wanjiru & O-Connor, 2015). A study of Kenyan secondary school children found that teaching mathematical vocabulary with a model that provides a graphic organizer integrated with technology effectively improved students' achievement in Mathematics (Wanjiru & O-Connor, 2015). Integration of technology with effective use verbal communication in the classroom enhances the opportunity of student who may learn better by visual or auditory presentation of information. An early research in educational psychology had suggested that individual difference in learning may exist between students who prefer visual presentation and those that prefer auditory presentation (DeBoth & Dominowski, 1978). In order to benefit effectively from verbal presentations in mathematics classrooms, student should be encouraged to acquire knowledge and skills that would enable them to better understand and use mathematical vocabulary.

This study was therefore designed to explore the comparative effects of using visual algebraic approach and verbal approaches of teaching quadratic equation. The study sought to investigate the effect of teaching with visual method (i.e. the use of diagram and concrete materials in presenting new concepts) and to compare this with the effect of the verbal algebraic method (i.e. predominant use of oral symbolic expression) on the achievement of student in Akamkpa Local Government Area.

Hypothesis

Ho1: There is no significant difference between the achievement of boys taught with visual algebraic approach and those of boys taught with verbal approach in mathematics.

Ho2: There is no significant difference between the achievement of girls taught with visual approach and those of girls taught with verbal approach in mathematics.

Methodology

The researchers adopted experimental design because the independent variable (Teaching method) was manipulated. The study population consisted of all Senior Secondary II (SSII) students in Akamkpa Local Government Area. Using stratified random sampling technique, a sample of 160 consenting students were selected for the study. The students were drawn from four schools with 40 students selected from each school; sampling was stratified to allow for comparable numbers of male and female participants. The forty respondents from each school were randomly assigned into two equal groups (twenty per study arm) using simple random sampling (done by balloting) to be taught using visual or verbal teaching method. This random sampling technique helped to minimize bias that might have been caused by potential confounders.

The visual method involved the use of concrete materials and pictorials such as charts and graph. On the other hand, the verbal method involved the use of logical verbal description of quadratic equation. The lesson objectives were that at the end of the lesson, at least 75 percent of the students should be able to: define an equation; define quadratic equation; solve simultaneous equation by quadratic method, prepare a table of values and plot the graph. The actual teaching was done by the researchers with four lesson sessions for each study group using the respective study methods namely visual method or oral method. Each lesson lasted for 40 minutes. In each of the four schools, the researchers taught the topic with visual method in experimental arm (20 students), and with the verbal method in the control arm (20 student). The test on solution of quadratic equation was administered to all study participants on completion of the four lesson sessions.

Table 1: Distribution of study sample by gender and school type

School type	Number of schools selected*	Number of students selected		
		Male	Female	Total
Mixed schools (male & female)	3	60	60	120
Boys only school	1	40	0	40
Total selected	4	100	60	160

**40 students were selected per school; ratio of male to female in mixed schools was 1:1*

The hypotheses were tested at 0.05 level of significance using the t-test for the data analysis of data because the study involved two independent groups. From the raw scores the mean and standard deviation were computed. These were used to calculate t-observed using the standard formula.

Presentation of results

Ho1: There is no significant difference between the achievement of boys taught with visual algebraic method and those of boys taught with verbal method in teaching quadratic equation.

Table 2: Independent t-test analysis to determine the achievement of boys taught with visual and those of boys taught with verbal method in teaching of quadratic equation

Variable	N_1 N_2	$\bar{x}_1$ $\bar{x}_2$	SD_1 SD_2	t-observed
Visual (boys)	50	11.24	4.21	6.60
Verbal (boys)	50	5.8	4.03	

Degree of freedom =98, Critical value = 1.96

Table 2 showed that the t-observed of 6.60 is greater than the critical t-value of 1.96 at .05 level of significance and 98 degree of freedom. Hence, the null hypothesis was rejected while the alternate hypothesis was upheld. This implies that there is a significant difference in the mean score of students taught quadratic equations using visual and verbal algebraic methods of teaching in the research area.

Ho2: There is no significant difference between the achievement of girls taught with visual algebraic method and those of girls taught with verbal algebraic method in teaching quadratic equation.

Table 3: Independent t-test analysis to determine the achievement of girls taught with visual method and those of girls taught with verbal method in teaching of quadratic equation

Variable	**N_1** **N_2**	**$\bar{x}_1$** **$\bar{x}_2$**	**SD_1** **SD_2**	**t-observed**
Visual (girls)	30	10.1	28.98	1.43
Verbal (girls)	30	2.37	5.48	

Degree of freedom = 58; Critical value = 1.96

Table 3 shows that there is no significant difference between achievement of girls taught with visual method and those of girls taught with verbal algebraic method in teaching of quadratic equations in all schools. Although the mean scores of girls taught with visual methods were higher than scores of the girls taught with verbal methods, the difference did not reach statistical significance at 0.05 level set for this study. This may be explained by the small sample size which lacked the study power to detect the difference at this critical level. Although this study used probability sampling, the sample size calculation did not include an assumption for likely gender differences.

Discussion of findings

The first finding of the study which arose from testing of the first hypothesis indicated that there is significant difference between the achievement of boys taught with visual algebraic method and those of boys taught quadratic equation with verbal method. This means that the achievements of the two groups are different from each other. Since the mean score of visual method of 11.26 is statistically greater than that of verbal algebraic method, it means that students taught with the former outperformed those of the latter. The reason for this may be that students tend to understand and retain more when taught with visual method than when taught with verbal algebraic method. This is in concord with the previous reports of Sonerhed (2009) and Kieran (2007) who were of the view that presentation of concrete materials gives more understanding than those of verbal.

The second finding of the study indicated that there is no significant difference between achievement of girls taught with visual method and those of girls taught with verbal algebraic method in teaching of quadratic equations. As Deboth and Dominowski (1978) observed, there appears to be a general belief that within a group of students, some would learn better from visual presentation, while others tend to learn better from auditory presentation; but these researchers concluded that their own study could not "give support to the contention that students can be classified as auditory learners or visual learners." A more recent study by Korenman and Peynircioglu (2007) involving students of music suggested that learning style preference made a difference. The study showed that visual learners learned visual

presentations faster and remembered them better than those taught by auditory presentation, and auditory learners did the reverse.

Limitations: The relatively small sample of female students included in this study was a limitation. Despite the fact that sample selection in this study was by a probability sampling approach, the sample size calculation did not include an assumption for likely gender differences. The study was therefore not adequately powered for the testing of the second hypothesis hence the inconclusive result; although the direction of effect suggested that the use of visual approach was more effective than the oral approach of teaching quadratic equation.

Also the quantitative research design applied in this study was appropriate for assessing the effect of visual and verbal teaching methods but did not address the likely influence of contextual factors. Adopting a combination of quantitative and qualitative research methods could have provided the information on effectiveness of visual approach to teaching as well as explore the contextual factors that may have influence on the observed effects. Ross, Morrison and Lowther (2010) have similarly argued that the complexities associated with applying technology to educational research in this area of learning should not be limited to methods that generate only quantitative evidence on indicators of "effects" but should be based on "Mixed methods" research. "Mixed methods" research refers to studies that combine both quantitative methods (to yield data on effects or impacts), and qualitative methods (to yield data on the implementation processes and other contextual factors that potentially influence those effects) (Johnson & Onwuegbuzie, 2004).

Conclusion

The study revealed that boys who were taught quadratic equation with visual methods performed significantly better than boys who were taught with verbal-algebraic method; and that there was no significant difference between the achievement of girls taught quadratic equation with visual method and those of girls taught with verbal method, although direction of effect suggested that visual method could be more effective than oral approach. The conclusion of this study is therefore that using visual method to teach quadratic equation is more effective than using verbal approach.

Recommendations

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

1) Since the success of quadratic equations instruction is seen to depend on the selection and adoption of appropriate teaching method, it is recommended that proactive and urgent steps should be taken towards training Mathematics teachers on pedagogical skills that include effective and balanced use of visual and verbal methods of teaching algebraic equations.

2) Educational administrators, government and parents should provide adequate visual aids for secondary schools. In the same vein, teachers should also be encouraged to use improvised teaching aids when factory-made ones are not readily available.

3) Curriculum designers should lay more emphasis on visual presentation of topics in Mathematics.

4) There should be refresher courses for Mathematics teacher to keep them abreast with new methods and materials in Mathematics education.

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