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Developing computational fluency with whole numbers among primary school (IV) students' following Vygotsky's zone of proximal development in Katagum local government area of Bauchi state

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Abstract
The study was aimed to develop computational fluency with whole numbers following Vygosky's Zone of Proximal Development among primary school pupils. The study carried out on primary (iv) pupils in Katagum Local Government area of Bauchi state, Nigeria. Developing computational fluency becomes a problem of our students at primary school levels during learning process in Mathematics subject. These problem may arise due to teaching strategies applied in the teaching of Mathematics at the early stage of learning, as such our students has difficulty in understanding basic operations with numbers. This study adopted an experimental research which 50 primary (iv) students' was taught effectively and developed in computational fluency with whole numbers and the operation of addition, subtraction, multiplication and division. The result shows that students' performance and attitude improved significantly compared with those taught using conventional method. It is recommended that, the method the students' uses to compute should be grounded in understanding structure of the number system and the operations of addition, subtraction, multiplication, and division for constructing solid foundation to better learning of Mathematical concepts and Mathematic subject in general. And Computational fluency is an essential goal for school Mathematics.

Keywords: computation, computational fluency, whole numbers, basic operations

Introduction

Mathematics is more than doing. It is more than mechanical computation, and the essential aspect of Mathematics is a clear understanding of the Mathematical ideas and concepts. Principles and standards for school Mathematics National Councils of Teachers of Mathematics (NCTM, 2010) [5] emphasizes the goal of computational fluency for all students'. It articulates expectations regarding fluency with basic number combinations and the importance of computational fluency grounded in understanding. Dowker (2013) [2] holds that it also articulates the need for students' to develop procedural competence within a school Mathematics program that emphasizes Mathematical reasoning and problem solving. In fact learning about whole number computation is a key context for learning to reason about the base-ten number system and the operations of addition, subtraction, multiplication, and division. Thus one of the basic strategies in the establishment of Mathematical culture is the discovery of measuring in all Mathematical studies (Hilbert, 2009) [3]. However, in order to appreciate the technological and scientific revolution which is taking place today it is imperative that the schools should give adequate and added emphasis of the Mathematical computation fluency, procedures and methods of reasoning. Students' should not just memorize riles and procedures, they should be made to develop in computational fluency and to understand the rules and appreciate the procedure (Lawan, 2011). Moreover, based on the principles and standard of (NCTM, 2010) [5] computational fluency includes three (03) ideas: efficiency, accuracy and flexibility.

1. Efficiency implies that the students' does not get bogged down in many steps or lose track of the logic of the strategy. An efficient strategy is one that the students' can carry out easily, keeping track of sub problem and making use of intermediate result to solve the problem.
2. Accuracy depends on several aspects of the problem-solving process, among them careful recording, the knowledge of basic number combinations and other important number relationships, and concern for double checking results.
3. Flexibility requires the knowledge of more than one approach to solving a particular kind of problem. Students' need to be flexible to be able to choose an appropriate strategy for the problem at hand and also to use one method to solve a problem at hand and another method to double check the results.

Computational fluency demands more of students' than memorizing a single procedure does. Fluency rest on a well-built Mathematical foundation with three (03) parts base on the idea given by (Russell, 2013) [6].

1. An understanding of the meaning of the operations and their relationships to each other- for example, the inverse relationships between multiplication and division.
2. The knowledge of a large repertoire of number relationships, including the addition and multiplication.
3. A thorough understanding of the base-ten number

system, how numbers are structured in this system, and how the place value system of numbers behaves in different operations.

Moreover, it is said that Mathematics is the queen of the science, so one cannot study, understand, and appreciate science and live meaningfully and effectively in this age of science and technology without the knowledge of Mathematics, in order to assist in the establishment of Mathematical culture in our society. Therefore, every child should be given a good foundation and the opportunity to serve as much Mathematics as he can in order to participate meaningfully and effectively in the present day culture. To achieve the above, there is need for Mathematics educators (teachers) to put much emphasis in computational fluency at the primary school level re-branding good foundation of pupils to have efficient knowledge of Mathematics understanding as well as Mathematical computation with flexibility and accuracy on the structure of number system.

Statement of the Problem

The problem of this study is therefore, how our primary school pupils can develop computational fluency with whole numbers which can support pupils' to learn and understand the structure of the number system and the operations of addition, subtraction, multiplication, and division for constructing solid foundation to better learning of Mathematical concepts and Mathematic subject in general.

Research Questions

The following research questions were formulated to guide the study

1. Does the pupil know and draw on basic facts and other number relationships?
2. Does the pupil use and understand the structure of the base-ten number?
3. Does the pupil use relationships among operations of addition, subtraction, multiplication, and division

Scope of the Study

The study was delimitated to raise primary school (iv) pupils' background in developing computational fluency with whole numbers in Bauchi state

However, the purpose of this study is therefore, to discuss the method and procedures to follow that will guide the researcher in developing computational fluency among primary school (iv) pupils.

Design of the study/Procedure

The research employed an experimental research design, associated with quantitative and qualitative parameters (i.e. scores of the tests delivered and students' actions observed in developing computational fluency).Three (03) different instruments were used for data collection (test, videotaping and observational schedule). Test for quantitative aspect in finding pupils level of understanding on computational fluency, and potential level of the pupil that are involved in the research, videotaping and observational schedule record the qualitative aspect that took place during the teaching episode by following Vygotsky's ZPD, the ZPD was understood by Vygotsky to describe the current or actual level of development of the learners and the next level attainable through the use of environmental tools or capable adult or peer facilitation. However, the idea is that individuals learn best when working together with others during joint collaboration, and it is through such collaborative endeavors with more skilled person's that learners learn and internalize new concept. Specifically, the study incorporated with pretest, sequence of teaching intervention and post-test. Data collected from pre-and post-test form the quantitative aspect of the study while the data collected from videotaping and the observation of students' actions and participation during the teaching intervention constituted the qualitative aspect of the research. The estimate duration of the whole research is three (03) weeks. Moreover, the selection of the schools involved in the study was done by stratify cluster sampling technique, and the classes selected by random sampling technique. Lesson plans for teaching were prepared for each lesson during the teaching period. Test and information recorded in the videotape and observational schedule served as the instrument for data collected. And the quantitative aspect of the data collected was analyzed based on the mean and standard deviation of pupils' scores, on the other side the qualitative aspect of the data discussed base on the pupils' actions and participation during the teaching intervention and their level of understanding computational fluency working with whole numbers.

Population/ Sample of the Study

The population of this study comprised all the primary pupils in Bauchi State. The sample of the study consisted of one intact class of primary IV pupils of sixty (60) pupils which are randomly selected from the study school.

Instruments of the study

The instruments used for this study include test, videotaping and observational schedule for the data collected. Lesson plan prepared by the researcher were used during the classroom instruction (teaching intervention) and videotaping by the research assistant, while observational scheduled was also designed which recorded students' actions and participation during the teaching intervention.

Validation/Reliability of the Instrument

Face and content validation of the instrument were ascertained by two evaluation specialist and four experts in Mathematics Education. Final copies of the test were produced with strict adherence to the observation made by the experts. The test items satisfied difficulty index of 0.56 to 0.75 and discriminating power of 0.51 to 0.65. Also the instrument had a split-half reliability coefficient of 0.75 using Spearman Brown Prophecy formula.

Data Collection Procedure and Analysis

At the end of the teaching periods, the researcher administered post-test to the students. The answer scripts collected (pre-test and post-test) were marked and scored. Students' behavior, attitudes during the teaching experiment were observed and recorded using an observational schedule.

Table 1: Result of the Pre-test (Calculated Mean and Standard Deviation of the Two Groups)

Group	Mean (X)	Standard Deviation (σ)
Control	46.9	19.4
Experimental	48.7	18.9

The result indicated that the two groups were homogeneous. Moreover, the researcher mate the principals of the schools selected for the study and discussed about the research-assistants who were the regular Mathematics teachers of the selected schools. Pupils were trained on teach the experimental group learned and understand the structure of the number system and the operations of addition, subtraction, multiplication, and division for constructing solid foundation to better learning of Mathematical concepts and Mathematic subject in general. And the researcher also taught the control group followed conventional learning method of teaching. Another research assistant acted as an observer which observed and recorded lessons delivered for both experimental and control group. An observational schedule were adopted from Lawan (2010), which were used in the study to observeand recorded students' actions and participation with their level of progressions throughout the lessons delivered. Moreover, the study lasted for three (3) weeks and Mathematics subject was allocated four (4) days in a week forty minutes per period. After the teaching period both the experimental and the control group were administered post-test. The result of the post-test was calculated and recorded in table 2. Discussions of the result followed.

Results

Hypothesis I

There is no significant difference in the mean achievement scores of mathematics students taught computational fluency and those taught using conventional method? The result of data analysis for this hypothesis is shown in table 2, table 3, and table 4.

Table 2: The Mean Achievement Scores and Standard Deviation of Trigonometric Achievement Test Scores in the Experimental and Control Groups.

Groups	No. of students	Pre-test		Post-Test	
		Mean	SD	Mean	SD
Experimental	50	48.7	18.9	73.05	10.6
Control	50	46.9	19.4	50.27	16.8
Diff. in mean				22.78	

The result in table 2 shows that for the post-test, the experimental group obtained a higher mean achievement score of 73.05 and standards deviation of 18.7, while the control group had a lower mean achievement score of 50.27 and a standard deviation of 16.8.

Table 3: Pretest Mean, Standard Deviation and t-test of Experimental and Control Group

Groups	N	X	SD	DF	t-calculated	t-crit	P
Experimental	50	48.7	19.9		0.12	1.25	0.05
Control	50	46.9	19.4	98			
Mean difference		1.8					

From table 3 the students in the experimental and control group were nearly at the same level. This showed that the two groups were not significantly different at the pre-test stage since the calculated t=0.12<11.98 which is the critical value at 0.05 level of significance.

Table 4: Mean, Standard Deviation and t-ratio of Experimental and Control Groups in the Post-test

Groups	N	X	SD	DF	t-calculated	t-crit	P
Experimental	50	73.05	10.6				
Control	50	50.27	16.8	98	2.76	1.98	0.05
Mean difference		22.78					

From table 4 the post-test results showed that there was a significant difference in the mean achievement of the students in the two groups. This was reflected by the t-test value of t=2.76 > 1.98 which is the critical value.

Based on the findings of the research the following conclusions were drawn.

1. Developing computational fluency strategy can improve pupils know and draw on basic facts and other number relationships towards understanding some computations in the class activity and give them opportunity to improve in their academic performance. These indicate that student' actions, participations and level of progressions in the experimental group are higher than the students' in the control group.
2. Develop computational fluency among primary pupils can also create a chance to use and understand the structure of the base-ten number.

Discussion

The result in table 4 indicated that students in the experimental group have higher achievement in computational fluency than the control group. This good performance could be attributed to the application of developing computational fluency. The result also supported researches that have shown some contributions of cooperative learning techniques which have stated in the introduction of this research work. Also table 4 showed a mean difference of 22.78 when comparing the mean of the two groups. This difference could be attributed to the fact that students in the experimental group were able to follow the guiding rules of working as a group. These rules are simply: explaining to group members' what the content is all about, making sure all group members are supportive of the group and every members of the group has learnt, comprehended, and is able to recall the concept learnt when the need arises.

Recommendations

The following recommendations were made based on the findings of this study

1. Computational fluency is an essential goal for school Mathematics.
2. The method that the students' uses to compute should be grounded in understanding structure of the number system and the operations of addition, subtraction, multiplication, and division for constructing solid foundation to better learning of Mathematical concepts and Mathematic subject in general.
3. Workshops should be organized frequently by educational bodies to emphasize and enlighten teachers and Mathematics Educators on the importance of developing computational fluency in learning the subject of Mathematics.
4. Additional research should be conducted on various

Mathematical concepts with computational fluency
5. Suitable source books on developing computational fluency should be made available.
6. Students' should be encouraged to use computational methods and tools that are appropriate for the context and purpose, including mental computation, estimation, calculators, and paper and pencil.

Conclusion

Developing computational fluency at primary school level has proved more effective approach in teaching Mathematics. Students taught using this approach performed significantly better than those taught using conventional approach. Thus some relationship exists between the technique of instruction and students' attitudes and skills in solving problems. Encouragement of students in computational fluency, participation in group work will equally enable students to develop proper Mathematical skills, attitude, knowledge and values which they can apply presently and in future for sustainable living.

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