EFFECT OF EXPLICIT INSTRUCTION ON THE MATHEMATICS ACHIEVEMENT OF PUPILS WITH DYSCACULIA

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Abstract

The purpose of this study was to experimentally determine the effects of Explicit Instruction (EI) strategy on the mathematics achievement of pupils with dyscalculia in Federal Capital Territory (FCT) Abuja putting into consideration gender as a variable. Two research questions were articulated and two hypotheses were formulated to guide the study. The study employed a quasi-experimental research design. Specifically, the nonequivalent control group design was used. The population for the study was all the 97 primary three pupils with dyscalculia in Local Education Authority (LEA) primary school Kpeyegie and Local Education Authority (LEA) primary school Garki as identified by the special education unit in AMAC local education authority Federal Capital Territory Abuja. Purposive sampling technique was employed to select the two case schools where the large number of children with dyscalculia would be found, being public inclusive schools. Then the sampled schools were randomly assigned to experimental and the control groups. In the schools selected, two intact classes comprising 20 primary three pupils made up of 11 males and 9 females were used for the study. The instrument for data collection was a 10-item Mathematics Achievement Test (MAT). The instrument was face and content validated. Using Kendall's Coefficient of Concordance (W), the reliability co-efficient of .88 was obtained for the MAT. Research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).The result of the study revealed that: EI has significant effect on the mean achievement scores of pupils with dyscalculia in mathematics; There is significant influence of gender on the mathematics achievement scores of pupils with dyscalculia. Based on the findings some recommendations made among which is that Explicit Instruction should be used in teaching mathematical concepts in primary schools so as to improve pupils' achievements and participation in the subject.

Introduction

Mathematics is the systematic treatment of magnitude, properties, relationships between figures and forms, and relationship between quantities and sets expressed using numbers and symbols. According to Gallan as cited in Lerner and Johns (2009), Mathematics is a symbolic language that enables human beings to think, record, and communicate ideas about the elements and relationships of quantity. It is not just a body of knowledge, but also a process of inquiry. Therefore, Momoh (2006) asserted that for a student to succeed in Mathematics, he or she should be able to make observations, organize information, specialize and generalize, express mathematical ideas and prove conjectures. They must be able to use memory to recall rules and formulas and recognize patterns; use language to understand vocabulary, instructions, and explain their thinking; and use sequential ordering and procedures to solve multi-step problems (Karp and Voltz, 2000). .

Equally there are basic mathematics skills people need to master that have daily importance and application in their lives. They are the simplest branch of Mathematics, whose basic functions include; addition, subtraction, multiplication, division and simple manipulation of numbers. Iji (2007) confirmed that the basic Mathematics skill operation covers adequate knowledge of addition, subtraction, multiplication and division. These are the key skills embedded in the primary school curriculum, within which mathematics has a significant role to play. The demands of the curriculum at this stage are high because this is the point at which children's acquisition of these basic Mathematical skills starts. Jordan and Levine (2009) stated that the truth remains that strong mathematics foundation at the primary school level will ensure smooth learning of mathematics and that competency in the use of basic numbers are formed at this primary school stage of learning. It influences their ability to participate in post-primary, post-secondary education and their expected future earnings. Therefore teaching that connects with early number competencies and that builds on these competencies is likely to be most effective for pupils with dyscalculia.

The importance of mathematics skills in individual's life notwithstanding, some learners still fail in mastering such basic concepts and skills leading to failure in both school internal and external examinations. According to Amazigo (2000), despite the relative importance of Mathematics, it is very disappointing to note that students' performance in the subject at both internal and external examinations has remained consistently poor. Students in secondary schools register continually poor results at junior secondary certificate examination (JSCE) in mathematics. The effect is evidenced in the poor performance reflected in the result of Mathematics for

May/June Junior secondary school certificate Examination (JSCE) in Abuja Municipal Area Council (AMAC). There is a marked drop for four consecutive years (2011 – 2014) in the area council. Considering that pupils with dyscalculia are included in the same UBE classrooms, their results are embedded in those poor performances for those years. This chronic poor performance generates a deep concern because inadequate mastery of mathematical process and fundamental concepts and skills from the primary level is probably the root cause of the difficulties and failures encountered by individuals of all ages both in examinations and in anything mathematical. According to National Key Result Area (NKRA) (2010), if the problems of mastering mathematics skills in primary schools were ignored continuously, cumulative academic failure will be difficult to be improved when the student enters a higher schooling stage. The consequence of it is worse off for persons with dyscalculia.

Dyscalculia as a type of learning disabilities is neither widely recognized nor well understood in Nigeria. The word 'Dyscalculia' according to Gaurav (2001) is a combination of two different words i.e. Latin word 'dys' meaning a form of special difficulties and the Greek word 'calculus' which means 'calculating' or counting. Thus the word literally refers to the special difficulties with counting. In more proper words it means specific (particular) or special difficulties with learning Mathematics. Rubinsten and Tannock (2010) defined dyscalculia as a specific deficit in the ability to process numerical information that cannot be ascribed to sensory difficulties, low IQ or inadequate education, and that results in a failure to develop fluent numerical computation skills. It can also be seen as a mathematical or arithmetic disability which manifests in peculiar difficulties in counting, concept of size, symbols and other areas of Mathematics even though good conventional teaching approaches are applied. This condition is not as a result of sensory or intellectual disabilities, school environmental issues or lack of home encouragement and materials. Children with dyscalculia can exhibit low Mathematics performance in many different ways. Some may have particular difficulties with arithmetical facts, others with procedures and strategies, while most of them seem to have difficulties across the whole spectrum of numerical tasks. In general learners with dyscalculia have difficulties understanding mathematics concepts and skills, appropriating sizes and time and solving even simple numerical problems.

In Nigeria, pupils with dyscalculia are in the same primary schools with those without disabilities. This is in line with the National Policy on Education (FRN, 2013) which has one of the aims as to provide access to education for all persons in an inclusive setting. This has great implications for

the education programme of children with dyscalculia in the sense that they use the same curriculum with other children without disabilities, are taught by the same teachers using the same methods and are assessed based on the same standard irrespective of their peculiar conditions.

One of the major causes of poor achievement in Mathematics in general has been attributed to ineffective teaching methods. Lawrence cited in Jordan & Levine (2009) asserted that invalid teaching methods are among the general factors affecting the academic performance in Mathematics in primary schools. In spite of various attempts by researchers in conducting intervention to identify the most effective instructional practices to tackle the problem of dyscalculia in Nigeria, the pitiable academic condition, still remains almost the same. For instance, Aremu and Taiwo (2014) investigated the effects of numerical cognition and emotional freedom techniques on mathematics anxiety among non-science students with pseudo-dyscalculia in Oyo State. The result was reported not to be high-point-based. Also, Tambawal (2009) had suggested that students with dyscalculia be allowed to use their fingers and scratch paper in counting and solving calculations because their memories may likely fail them. This calls for interactive and activity-based teaching which helps pupils with dyscalculia to both understand and master what they learn. It is against the backdrop that the researchers wish to employ explicit instruction strategy as intensive remedial intervention to investigate if there could be any remarkable positive difference in the mathematics achievement of pupils with dyscalculia.

Explicit instruction refers to teaching where the instructor clearly outlines what the learning goals are for the student, and offers clear, unambiguous explanations of the skills and information structures they are presenting (Jenkins 2012). According to Hudson, Miller and Butler (2006), it is an approach that combines specific design components and systematic instruction. This strategy equally involves using highly structured and sequenced steps to teach a specific skill. With this approach, the teacher intentionally aims to teach students with dyscalculia using a series of actions in three main stages: the teacher demonstrates to pupils with dyscalculia what they must do (modeling the practice); then guides pupils through a group activity (guided practice) so that students have the necessary skills to complete the task, and then the students practice the task independently (independent practice). In this last stage before the evaluation, the pupils are involved in peer tutoring and cooperative learning while the teacher plays the role of scaffolding and monitoring the pupils. This therefore improves the pupils' achievement in the content area.

Another area that has been of interest to researchers is the issue of gender on Mathematics achievement of learners. Gender is defined as a socially ascribed attributes which differentiates feminine from masculine (Okeke, 2007). It is the fact of being male or female. Literature about gender and achievement in Mathematics exist with different views and findings. Owolabi, and Adejoke, (2014) found contradicting but significant differences between male and female students in mathematics achievement, with male students significantly outperforming their female counterparts. Also females outperform males in Mathematics (Epstein et al in Owolabi, and Adejoke, 2014). However Abiam and Odok (2006) found no significant relationship between gender and achievement in number and numeration. Following these inconsistencies, this paper is deemed necessary to help resolve this controversy on the issue of gender as it affects Mathematics achievement.

Mathematics is of prime importance in everyday life, enabling people to comprehend number concepts and perform calculations, budgeting their time and monetary resources. Despite this landscape, some economically active individuals in countries such as Nigeria remain functionally innumerate. For those individuals, rates of unemployment, mental and physical illness, arrest and incarceration are higher. This is the plight of individuals with dyscalculia. The problem has to a large extent been attributed to ineffective teaching methods employed by the teachers – especially lecture teaching method which is teacher-centered. Consequently, there is felt need to improve on the teaching and learning of Mathematics by exploring the use of some innovative learner-centered teaching–learning methods, since it is believed that meaningful learning may be as a result of active participation by learners. Based on the foregoing, the problem of this study therefore is: could the use of explicit instruction (EI) strategy improve the mathematics achievement of pupils with dyscalculia in Federal Capital Terry Abuja. Furthermore what role will gender play in affecting mathematics achievement of these pupils?

The following research questions and hypotheses guided the study:

- What is the effect of Explicit Instruction (EI) and Conventional Lecture Method (CLM) on the mathematics achievement of pupils with dyscalculia?
- What is the influence of gender on mathematics achievement of pupils with dyscalculia?
- Ho_1 There is no significant difference between the mean achievement scores on mathematics of pupils with dyscalculia exposed Explicit Instruction and those exposed to Lecture Method.

- There is no significant influence of gender on the mathematics achievement of pupils with dyscalculia.

Method

This study employed a quasi-experimental design adopting the pre-test post-test non equivalent experimental and control group. The population was all 97 primary III pupils with dyscalculia of the Model inclusive primary schools in AMAC, Federal Capital Territory Abuja and the sample was 20 primary III pupils with dyscalculia drawn from intact classes in the two purposively selected inclusive primary schools in AMAC. AMAC was purposively chosen because it has the model inclusive primary schools that admit both regular pupils and those with special needs are admitted. LEA primary school Kpeyegie consisting of 6 boys and 4 girls with dyscalculia were assigned as treatment group and LEA primary school Garki consisting of 5 boys and 5 girls with dyscalculia were assigned as the control group.

The instrument used for the data collection was a 10-item essay Mathematics Achievement Test (MAT) measuring mathematics achievement level of primary three pupils with dyscalculia in addition (+), subtraction (–), multiplication (**x**) and division (÷). and was developed by the researcher. The MAT items were validated by three experts; one from Special Education, one from Mathematics Education and one from Measurement and Evaluation all in University of Nigeria Nsukka. Their inputs were used for modification of the MAT before it was administered. A reliability coefficient of .88 was obtained for the MAT using Kendall's Coefficient of Concordance (W) based on the result of the trial testing.

In each of the schools, the regular class teachers were used as assistants for the study. The teacher for the experiment group was trained on explicit instruction approach while the other was not. The trained teacher taught the experimental group using explicit instruction approach while the control group was taught by the other teacher using the conventional method. Before the lessons, both groups were pretested to ensure equal cognitive background.

The topics taught were addition, subtraction, multiplication and division of numbers with and without carrying. After four weeks of lessons both groups were given a post-test using transposed version of the instrument. Mean and standard deviations were used in answering the research questions. The research hypotheses were tested using the analysis of covariance (ANCOVA) at $p < 0.05$. The pretest scores were used as covariate to the post test.

Results

Table 1: Pretest and posttest scores of the effect of Explicit Instruction (EI) and conventional method (CM) on the mean achievement scores of pupils with dyscalculia in Mathematics

Variable		**Pre-test**		**Post-test**		
Instructional Strategies	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
EI	10	7.00	4.83	51.00	6.58	44.00
CM	10	8.00	5.37	15.50	7.25	7.50

The result on table 1 above shows that the pretest mean achievement scores obtained for pupils exposed to EI (experimental group) was 7.00 with a Standard Deviation of 4.83 and a posttest mean of 51.00 with a Standard Deviation of 6.58. The difference between the pretest and posttest means was 44.00. The result in Table 1 also shows that the pupils exposed to CLM (Conventional Lecture Method) had a pretest mean achievement scores of 8.00 with a Standard Deviation of 5.37 and a posttest mean of 15.50 with a Standard Deviation of 7.25. The difference between the pretest and posttest means was 7.50. For both groups exposed to EI (experimental group) and LM (Lecture Method), the posttest means were greater than the pretest means. However, pupils with dyscalculia who were exposed to EI (experimental group) had a mean gain of 44.00 which is higher than 7.50 for their counterparts who were exposed to the LM (Lecture Method). This is indicative that the use of Explicit Instruction (EI) seems to improve the achievement scores of pupils with dyscalculia in Mathematics than the Lecture Method (LM).

Table 2: Analysis of Covariance (ANCOVA) of the significant difference in the mean achievement scores of pupils with dyscalculia when exposed to explicit instruction (EI) and those exposed to conventional method (CM).

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6539.695[a]	4	1634.924	39.298	.000
Intercept	4615.667	1	4615.667	110.944	.000
Pretest	220.945	1	220.945	5.311	.036
Groups	6449.439	1	6449.439	155.021	.000
Gender	10.844	1	10.844	.261	.617

Groups * Gender	16.849	1	16.849	.405	.534
Error	624.055	15	41.604		
Total	29275.000	20			
Corrected Total	7163.750	19			

The result in Table 2 shows that an F-ratio of 155.02 with associated probability value of 0.000 was obtained with respect to the difference in the mean achievement scores of pupils with dyscalculia exposed to explicit instruction (EI) and those exposed to the conventional method (CM). Since the associated probability (0.000) was less than 0.05 level of significance set as the benchmark for taking a decision, the null hypothesis (H_{01}) was rejected. The inference drawn is that there was a significant difference in the mean achievement scores of pupils with dyscalculia in mathematics when exposed to Explicit Instruction (EI) and those exposed to the Conventional Lecture Method (CLM).

Table: 3. Mean and standard deviation analysis of influence of gender on mathematics achievement of pupils with dyscalculia

Gender	**N**	**Mean**	**SD**
Male	22	20.68	19.47
Female	18	20.00	19.25

The table above shows that the male respondents had a mean of 20.68 and Standard Deviation of 19.47 while the female respondents had a mean of 20.00 and Standard Deviation of 19.25. The difference in the mean scores of the two groups was calculated as 0.68 which was statistically low. Therefore, there was slight influence of gender on mathematics achievement of pupils with dyscalculia.

Going by the data on table 2 above on the influence of gender on Mathematics achievement, the Male–Female difference is not significant .617 > 0.05. This resulted to the acceptance of the hypothesis. Therefore, there was no significant influence of gender on the Mathematics achievement of pupils with dyscalculia in of males.

Discussion

As shown on table 1, there is a difference between the mean achievement scores of the two groups of pupils with dyscalculia (Experimental/Explicit Instruction and Control/Conventional Lecture Methods). The analysis revealed that pupils with dyscalculia taught with EI

performed significantly better in the Mathematics achievement test than their counterparts who were taught using the Conventional Lecture Method. Results in table 2 further confirmed this finding by indicating statistically significant effect of Explicit Instruction on the pupils achievement in Mathematics. The pupils' achievement in Explicit Instruction was better than in the Conventional Lecture Method. This finding is in agreement with the results of earlier studies carried out by Adedeji (2013) and Oinorod (2015) who found in their separate studies, that explicit instruction was more effective than the conventional methods in fostering learners' achievement in Mathematics. The relative superiority of explicit instruction over the lecture method in enhancing learners achievement in Mathematics could be attributed to the fact that, as a teaching method the EI is learner-centered and ensures active participation and interaction of learners with learners and the teacher in the teaching learning process more than the Conventional Lecture Method. Furthermore, in the socio-cultural theory by Lev Vygotsky learners are guided and supported through learning activities that serve as interactive bridges to get them to the next level (Kozulin, Gindis, Ageyev and Miller 2003).

Finally, the result of the study on table 3 revealed a little difference in the post-test mean achievement scores of male and female pupils with dyscalculia taught mathematics skills using Explicit Instruction which was in favour of the male pupils. This result indicates that gender is not a significant factor on students' achievement in Mathematics. This report is in contrarily with earlier findings of Olosunde and Omolayo, (2010) which has indicated that male learners consistently obtained significantly higher in mathematics achievement scores than their female counterpart and Agwagah's findings in Unodiaku (2014) revealed that female students made higher gains in the mean achievement score than the male students. These findings revealed that the issue of gender as a factor of Mathematics achievement is inconclusive. There is therefore need for further enquiry to clarify this notion.

Conclusion

The study was carried out to determine the effect of Explicit Instruction on Mathematics achievement of pupils with dyscalculia. The study revealed that Explicit Instruction significantly enhanced the achievement of students in Mathematics than the conventional methods, it had a slight difference in gender effects in favour of males and it encouraged the pupils' classroom participation.

Recommendations

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

1. Explicit Instruction should be used by Mathematics teachers in teaching mathematical concepts in primary schools so as to improve pupils' achievements and participation in the subject.
2. Seminars, workshops and symposium should be organized by the government to train primary teachers on how to use effective instructional approaches such as Explicit Instruction in teaching Mathematics.
3. Mathematics curriculum planners should integrate and lay emphasis on Explicit Instruction approach in the restructuring of the curriculum so as to help pupils with dyscalculia achieve better understanding of important concepts and skills in the subject.

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