ASSESSMENT OF THE IMPACT OF PROBLEM-SOLVING METHOD ON PUPILSACADEMIC ACHIEVEMENT IN MATHEMATICS

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Abstract

This study examines the impact of problem-solving method on pupils' Academic Achievement in mathematics. A pre-test post-test control group quasi experimental design was adopted for the study. Based on the purpose of the two research questions and two hypotheses were formulated and tested at 0.05 level of significant Data were collected from a sample of 117 pupils made up of 42 males and 75 females using simple random sampling techniques. The experiment was carried out on three (3) groups of pupils. Pupils in experimental groups 1 and 2 were exposed to treatment (problem-solving approach) while the control group was taught using the conventional lecture method. Face and content validity of the instrument was done by three experts, one from mathematics education and two from measurement and evaluation. The reliability co-efficient obtained for MAT using kuder-Richardson was 0.85. Mean and standard deviation were used to analyze the research questions while Analysis of Covariance (ANCOVA) was used test the hypotheses. The findings revealed that problem-solving instructional strategy improves learner's performance in mathematics irrespective of gender. Based on findings, it was recommended that Primary School teachers who are already in service should be given adequate training through workshops, symposia, conferences and seminars to enhance and acquire better strategies of teaching mathematics.

Keywords: Problem-Solving, Academic Achievement andMathematics.

Introduction

Mathematics is one of the subjects that are taken very seriously in the school system, irrespective of country or level of education. It has been described as a model of thinking (Nostrand,2020), which encourages learners to observe, reflect and reason logically about a problem and in communicating ideas, making it the central intellectual discipline and a vital tool in science, commerce and technology (Imoko and Agwagah, inUnamba, Ugochukwu&Ewunonu2020). In the words of Schleicher (2013), mathematics is a precursor of scientific discoveries and inventions. It is the foundation for any meaningful scientific endeavour and any nation that must develop in science and technology must have a strong mathematical foundation for its learners. In terms of curriculum relevance, mathematics is compulsory at all levels of education system and a prerequisite for moving from the Primary, junior to senior secondary school; just as at the tertiary level of education, a sound background in mathematics is a necessary condition for the study of science, technology and social science courses, as required by the Nigerian examination bodies.

Despite the recognition accorded to mathematics due to its relevance, Allan (2011) remarked that learners exhibit non-chalant attitude towards mathematics, even when they know that they need it to forge ahead in their studies and in life. Such learners who have already conditioned their minds that mathematics is a difficult subject are usually not serious in the learning of mathematics and therefore perform poorly in mathematics tests and examination (Unamba, Ngozi, Grace & Chukwudeblu, 2022). They went further to report that school mathematics examination result shows that pupils' performances in mathematics are consistently poor. The deplorable state of mathematics performances of primary school is attributed to a number of factors such as attitude of learners (Uhumuavbi and Umoren inUnamba, Ugochukwu & Ewunonu 2020); lack of instructional resources (Bautista, Canadas, Brizuela and Schliemann,2015); Instructional techniques (Olulonye, 2022) among others. Although many factors affect pupil's mathematics learning and achievement, one factor over which schools have the most immediate

control is the choice of mathematics program to be implemented by teachers, administrators and curriculum developers. Instructional technique adopted by the teachers can be manipulated to bring about improvement among the learners. Several studies have shown that good instructional strategies are capable of improving the performance and achievement of learners in mathematics and other subjects (Iji, 2005 in Unamba, Ugochukwu & Ewunonu, 2020).Though this may be visible if a teaching strategy that takes into cognizance of pupils' achievement and science process skill such a strategy that possesses those attributes is the problem-solving method.

Problem solving involves application of thinking and reasoning to various kinds of problems encountered in life. Problem solving is an integral part of developmental activities and provides opportunities for learners to practice what they have learned by applying their learning situations. Problem solving method is a learning model which centers on learners to develop active learning, skillsofproblem-solving and improvesknowledge, and it is based on understanding and problemsolving (Major, Baden & Mackinnon, 2000). In the problem-solving learning model, the learners' turn from passive listeners of information receivers to active, free self-learner and problem solvers. It also shifts the emphasis of educational programs from teaching to learning. It enables the pupils to learn new knowledge by facing the problems to be solved instead of feeling boredom. Problem based learning affect positively certain other attributes such as problem solving, information acquisition, and information sharing with others, group works, and communication etc. Again, problem-solving is a deliberate and serious act, involves the use of some novel method, higher thinking and systematic planned steps for the acquisition set goals. The basic and foremost aim of this learning model is acquisition of such information which based on facts (Yuzhi, 2003 & Mangle, 2008). According to Gallagher in Unamba, Ugochukwu & Ewunonu (2020)in problem-based learning environment, learners act as professionals and are confronted with problems that require clearly defining and well-structured problems, developing hypothesis, assessing, analyzing, utilizing data from different sources, revising initial hypothesis as the data collected developing and justifying solutions based on evidence and reasoning. The practice of problem-solving learning is richly diverse as educators around the world and in a wide range of disciplined have

discovered it as a route to innovating education, The educators used problem solving method as an educational tool to enhance learning as a relevant and practical experience, to have learners' problem-solvingskills and to promote pupils' independent learning skill. Eng (2001) opined problem-based learning as a philosophy aims to design and deliver a total learning environment that is holistic to learner- centered and pupil's empowerment.

Presenting the learners with a problem, give them opportunity to take risks, to adopt new understandings, to apply knowledge, to work in context and to enjoy the thrill of being discoverers. Tick (2007) stated that in the learner-centered learning environment that is desirable for problem-basedlearning; the central figure of the learning-teaching process is the learners. The learning objective is not the reproduction, recall and learning of passively received learning material but the active and creative engagement of learners in group work and in individual study thus transferring the skills and knowledge. The individual, autonomous self-directed learning gives the freedom to the learner to decide individually and consciously on the learning strategy and on the time scale, s/he wants to follow.

Problem solving method (PSM) was designed to prepare learners to relate the content of the lesson to the real-world situation, and solve problems through activities and investigations based on the theories, concepts and principles that they have learned (Chin & Chia, 2004; EviSuryawati, 2006; Shipra Vaidya, 2009; Ibrahim &Nur, 2002). It was also designed to help learners develop the thinking and communication skills to succeed (Duch & Groch, 2001), while the unstructured problems in PBM help them to increase their cognitive process and improve their reviewing skills (Chin & Chia 2005) and also help them to be able to fulfill the demand caused by the era of information technology and globalization (Mohd Ali, 2008). Through this method, real life problems can be presented to learners in a relevant way. Learners actively participate in groups to solve problems as teachers just act as a facilitator in the construction of their knowledge. Teachers centralize their attention to helping learners to achieve the self-directed learning skill (Pasek 2008). This method encourages active learning and fosters critical, reflective and receptive thinking (Desmita, 2006; Liliasari, 2000) and learners are able to know what and why they are learning what they are learning in the

construction of their knowledge (Chin &Chia, 2004). Mohamad (2012) stated that PBM impacts beginner and advanced learners differently, and also it can lessen the gap that exists between these two groups, thus helping the beginner learners to learn better. Roh, (2003) argued that within problem-based learning environments, teachers' instructional abilities are more critical than in the traditional teacher-centered classrooms. Beyond presenting mathematical knowledge to the learners, teachers in problem-based learning environments must engage learners in marshalling information and using their knowledge in applied sand real settings. The mastery of problem solving method will help learners irrespective of gender.

Also, researchers like Atouigba, Vershima, O'kwu and Ijenkeli (2012) postulates that there has been global concern about gender differences in pupils' performance in Mathematics and some researchers have been undertaken in many parts of the globe in this respect. Some researchers have reported gender differences while others have that there are no significant difference in male – female Mathematics performance at any level. For instance, Bassey, Joshua &Asim (2015) indicated that, there exists significant gender difference in rural students Mathematics achievement in favour of males in Nigeria. Awofala (2020) discovered significant differences in the Mathematics performances of male and female pupils in favour of males. Atouigba, et al (2012) indicated that there is a significance difference in the mean scores of male and female pupils as male pupils achieved higher in mathematics than female pupils.

Fox, Brody &Todom,Hedges&Nowell, Peterson &Fennena, Randhava inUnamba, Ugochukwu&Ewunonu (2020)shows that boys generally achieved higher than girls on mathematics tests. However, others suggest that females perform better than male (Hydea&Mertzb, 2009). All these indications of existence of gender differences in mathematics achievement are due to teachers' use of traditional method of teaching which is not learners centered approach and such does not allow the children to express themselves. Unamba, Nwaneri& Nelson (2017) found no significant difference on gender achievement in geometry using 7E as instructional model. Ukaegbu, Unamba& Ugo (2016) found no significant difference on gender achievement in geometry using geogebra software in teaching. Unamba, Onyekwere&Ihekwaba (2015) found no significant difference on gender achievement using activity-based learning

strategy. Unamba, Onyekwere&Ugochukwu (2017), found no significant difference in achievement motivation and academic achievement engagement of pupils in mathematics classroom.

Several studies focus the change in knowledge and skill levels that occur with problem-solving techniques. A study was conducted by Farooq (2017) for development of critical thinking and reasoning in the pupils. The problem-solving approach is more useful than the traditional approach. Gesi and Massaro (2019) explore experiment discovery and expository methods in teaching visual consonant and word identification. Nevertheless, performance for all three groups (discovery, expository, and no training) improved during training in the word identification task. Schultz (2016) has examined the Average Ability Middle School Student and Concrete Models in Problem-Solving: A Look at Self-Direction. The average ability students showed the greatest gain in demonstrated problem-solving ability and the greatest use of concrete models. Blanier and Worthen (2017) examined a study of discovery and expository presentation with implications for teaching. The concept retentions tests scores showed that the discovery method produced superior results compared to the expository method. For attitude, neither comparison between the discovery method and expository method in measure of attitude reached a significant minimum acceptable level. Luzmanuel (2019) explored a study about college students' methods for solving mathematical problems as a result of instruction based on solving problems (problem-solving). These results lead to the conclusion that it takes time for students to conceptualize problem-solving strategies and use them on their own when asked to solve mathematical problems. Marilyn (2018) reported that the use of counting strategies to solve subtraction problems was also noted by Steinberg. She taught second graders to use derived fact strategies in which known number facts are used to find the solution to unknown facts. After eight weeks of instructions, children more than doubled their use of the derived facts, which involves more mature ways of thinking than relying solely on counting.

Nuzum (2020) developed an instructional package for teaching arithmetic story problem skills and examined the efficiency of that method on the story problem performance of four learning disabled students. A single subject design with three replications was used. The finding of study showed that a method, which includes instruction to mastery

method, task specific and procedural knowledge, was responsive to the needs of the learning disabled in this study. Each subject's problem-solving performance improved substantially. Chang, Kaur, Koay& Lee (2001) investigated the pedagogical practices within primary mathematics classrooms in four Singapore schools. In all, a traditional teaching approach predominated amongst the primary teachers - expository teaching, followed by the students practicing routine exercises to consolidate the concepts, knowledge and skills. Result showed that problem solving method scored high among other teaching methods.Therefore, this study intends to investigatethe Impact of Problem-Solving Method on Pupils Academic Achievement in Mathematics.

Purpose of the study

The main purpose of the study was to assessthe impact of Problem-Solving Method on Pupils Academic Achievement in Mathematics. Specifically, the study will determine whether.The following Research Questions and Hypothesis guided the study

1. What are the mean achievement scores of pupils taught mathematics using problem solving method and those taught using conventionally approach?
2. What are the mean scores of male and femalepupilsusingproblem-based method and those taught using conventionally method.The following hypotheses were formulated to guide the study:

Ho_1: There is no significant difference between the mean scores of male and female pupils taught mathematics using problem solving method and those taught using conventionally method.

Method

The research design used for this study was quasi-experimental. This design randomly presented three intact classes (two experimental groups and one control group). Experimental Group 1 got involved in problem solving coupled with Remediation and Experimental Group 2 got involved in problem solving coupled with feedback while the Control Group got involved in traditional approach. The population of the study comprised of all 407 primary five (basic 5) pupils in demonstration primary school of AlvanIkoku federal college of education in Owerri Municipal Area of Imo

State Nigeria.The sample for this study was 117pupils. Three (3) classes were randomly drawn for this study using simple random sampling technique. The researcher ensured that the sample pupils have the same psychological factors in common regarding their chronological age, mental development, cultural background and mathematics experience.The group were selected based on the facts that the subjects had been taught the basic and prerequisite mathematics concepts necessary for understanding of basic mathematics and geometry which were discussed in this work. Oneresearch instruments and one instruction package were used for data collection. They are: mathematics Achievement Test (MAT). This is made up of Sixty (60) four options multiple choice items based on the topics treated in the study (basic mathematics and geometry) used for the study. The MAT was designed to measure pupils' achievement (learning outcomes) in Mathematics. Experts in the field of mathematics Education validated the MAT in terms of ensuring items clarity and removal of ambiguous words that could confuse the pupils. The reliability co-efficient obtained for MAT using kuder-richardson was 0.85. Instructional Package of Nine Teaching manuals were used for treatment in the study. Four of the teaching manuals were taught for 40 minutes each while the rest were taught for 80 minutes (i.e. Double Period) lesson period. The Experimental Groups were taught using Problem-Solving Model with varying modes of instruction while the Control Group was taught using the Conventional Lecture Method. The procedure for data collection was in three main phases and it lasted for seven weeks. The phases were: Pre-test for the first one week, treatment for five weeksand Post-test for the last one week of the seven weeks. Prior to the collection of data, the participating teachers and pupils were trained. The training programme lasted for two weeks. The training of the teachers and pupils focused on the use of problem solving method and the different treatment conditions. The teachers and the pupils in the control group were not given any special training. Pre-test instruments were administered in the following order: the mathematics achievement test on pupils. In the Experimental Group treatment group involved the following steps. - Teachers presented the topic in form of discussion with the demonstration of the how to solve given problems using the PSM for pupils based on Groups.Teachers recognized the performance of the pupils in each of the Group. - Teachers gave assignment while the control group

treatment for each lesson involved the following steps: - The teacher presented the topic in form of lecture. - Pupils listened to the teacher and wrote down the chalkboard summary. - Pupils asked the teacher questions on areas of the topic that is not clear to them. - The teacher also asked the pupils questions and the pupils responded accordingly. - Pupils were given problems to be solved while the Teacher marked to assess their performance. Post-test After seven weeks of treatment, the MAT- whose items had been re-arranged was administered as the post-test on the experimental and the control groups. The SPST was re-administered again. Analysis of Covariance (ANCOVA) was used to analyze the data. Scheffe's Pairwise comparison was also used to establish the variation due to treatment and to locate the source of significance.

Results

Research Question one: What are the mean achievement scores of pupils taught mathematics using problem solving method and those taught using conventionally approach?

Table 1: Summary of pupils means achievement scores

		Pre-test score		**Post test score**		**Mean Gain score**
Group	**N**	**MEAN**	**SD**	**MEAN**	**SD**	
EGI	38	51.32	8.44	84.08	9.65	32.76
EG2	40	52.50	13.87	75.75	9.31	23.25
CG	39	66.28	10.99	54.36	10.27	11.92

EG1= Experimental Group 1, EG2=Experimental Group 2, CG= Control Group.

Table 1 showed that the highest mean gain in acquisition of problem was obtained by the pupils in EG1 (MGS=32.76). This was followed by students in EG 2 (MGS=23.25). The least mean gain was obtained by pupils in the control group (MGS=11.92)

Research Question two: What are the mean scores of male and female pupil's usingproblem-based method and those taught using conventionally method

Table 2: Mean gain scores in the problem solving of pupils based on strategies and gender

			Pre-test score		**Post test score**		**Mean Gain score**
Group	**GENDER**	**N**	**Mean**	**SD**	**Mean**	**SD**	
EGI	Male	14	47.50	8.03	87.71	9.17	38.21
	Female	24	53.54	8.01	83.13	9.98	29.59
EG2	Male	17	57.94	16.40	71.47	8.80	13.53
	Female	23	48.48	10.27	78.91	8.52	30.43
CG	Male	11	75.45	10.36	54.55	10.36	20.90
	Female	28	62.68	9.08	54.29	10.43	8.39

Table 2 revealed that the male pupils in the experimental group 1 had the highest mean gain in problem solving (MG=38.21). This was followed by the female students in experimental group 2 (MG=30.43). The least mean gain was obtained by the female students in the control group (MG=8.39).

Hypotheses testing

Ho_1: There is no significant difference between the mean scores of male and female pupils taught mathematics using problem solving method and those taught using conventionally method.

Table 3 Summary of ANCOVA on the difference in the mean scores among Pupils for problem solving based on gender

Source of variation	**Type III Sum of Squares**	**Df**	**Mean square**	**F**	**Sig**
Corrected Model	18301.889	4	4575.472	47.813	.000
Intercept	22069.230	1	22069.230	230.622	.000
Pretest	25.281	1	25.281	.264	.608
Group	12587.475	2	6293.737	65.769	.000
Gender	62.744	1	62.744	.656	.420
Error	10717.769	112	95.694		
Total	624225.000	117			
Corrected Total	29019.658	116			

Table 3 showed that there was no significant difference in the mean scores (F1, 112=.656, p>.05) by the male and the female pupils taught using Problem solving method. The significant level of 0.420 from SPSS is greater than the stated 0.05 significant level. Therefore, HO_2 is retained.

Discussion

The result revealed that the problem solving can actually be developed to meet the 21st century needs by integrating it into mathematics curriculum. Finding from the analysis showed convincingly that the problem- solving method proved to be a more effective and reliable method of teaching because it improves academic achievement of pupils in mathematics than the conventional lecture method. This finding provided empirical support to earlier findings: Bodner (2000) which remarked that there is significant improvement in pupils' achievement and science process skills when problem-solving. Other empirical studies which gave positive effects of problemsolving methods on achievement in other science subjects includes Martin and Oyebanji (2000), Decorte and Scriners (2002), Payne (2004).A study by Farooq (1980) for development of critical thinking and reasoning in the pupils. The problem-solving approach is more useful than the traditional approach. Gesi and Massaro (1991) explore experiment discovery and expository methods in teaching visual consonant and word identification. Nevertheless, performance for all three groups (discovery, expository, and no training) improved during training in the word identification task. Schultz, (1984) has examined the Average Ability Middle School Student and Concrete Models in Problem-Solving: A Look at Self-Direction. The average ability students showed the greatest gain in demonstrated problem-solving ability and the greatest use of concrete models.

Also, the results in indicated that problem solving method show no significant difference on gender performance in mathematics. The result also revealed that both the male and female were enhanced in mathematics. This implies that there are vocations that the male gender excels in and also vocations that the female gender excels in. In this study the male pupils' problem solving was highly developed in remediation than their female counterpart. On the other hand, the female pupils were highly developed in feedback than their male counterpart. This result is in accord with finding ofUnamba, Nwaneri& Nelson (2017) found no

significant difference on gender achievement in geometry using 7E as instructional model. Ukaegbu, Unamba& Ugo (2016) found no significant difference on gender achievement in geometry using geogebra software in teaching. Unamba, Onyekwere & Ihekwaba (2015) who found no significant difference on gender achievement using activity-based learning strategy. Unamba, Onyekwere & Ugochukwu (2017), found no significant difference in achievement motivation and academic achievement engagement of pupils in mathematics classroom.

Conclusion

The major conclusion that could be drawn from the study based on the performance of students is that the conventional lecture method of teaching mathematics proved less effective than the problem-solving method. In addition, the incorporation of problem-solving into mathematics learning improves the performance of pupils. If problem-solving instructional strategy could improve learners' learning outcomes in mathematics, it would be necessary to overhaul the mode of instruction of teaching mathematics at the primary school so as to accommodate functional student–centered and activity-oriented instructional strategy that will make pupils good problemsolvers, thereby causing improvement in the performance of students in Examinations thereby replacing the Conventional Lecture Method (i.e Chalk and Talk Method) of teaching in Schools.

Recommendations

1. Primary School teachers who are already in service should be given adequate training through workshops, symposia, conferences and seminars to enhance and acquire better strategies of teaching mathematics.
2. Schools' Curriculum should be overhauled to accommodate problem-solving and activity-oriented instructional strategies.

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