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Relative Effectiveness of Two Problem - Solving Models on Students' Performance in Further Mathematics in Senior Secondary Schools in Rivers State.

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Abstract

This study was designed to determine the relative effectiveness of two problem-solving models on students' performance in further mathematics. The problem-solving models considered were Rubenstein Model and Krulik & Rudnick Model. Three co-education public senior secondary schools, randomly selected from Port Harcourt Metropolis, were involved in the study. A total of 180 ss2 further mathematics students from these schools were selected for the study. This comprised of 35 boys and 25 girls in each school. The schools were randomly assigned to experimental and control conditions. Pre-test was administered to all the groups before the treatment. After treatment the posttest was administered. The researchers taught these different groups at different lesson periods in their individual schools. The statistical tool used for the study was a 3 x 2 factorial analysis of variance. Scheffe's post hoc test was used to check for particular pairs with significance. The results showed that Rubenstein model was most effective, followed by Krulik & Rudnick model and lastly the algorithm. Gender difference was insignificant. From the findings, teachers are encouraged to attend seminars/workshops on problem – solving models in order to facilitate the teaching and learning of further mathematics in schools.

INTRODUCTION

Mathematics is the bedrock of all scientific technological investigations and all activities of human development. It provides the route to modern world of science and technology. For students to become good problem- solvers in mathematics they need to be exposed to many problems- solving models developed by distinguished mathematics educators, which are capable of enhancing the teaching of mathematics and consequently improving students' performances in the subject. As recorded by Alio and Peter (2000), these models include target task, formal and Bransfords ideal model, Krulick & Rudnicks (1989), Rebenstenstein (1975), and Johnson (1975).

Problem solving has been defined as higher-order cognitive process such as visualization, association, abstraction, comprehension, manipulation, reasoning, analysis, and synthesis, generalization that requires the modulation management, coordination control of more routine or fundamental skills (Goldstein & Levin, 1987, Garofalo & Lester, 1985). Beginning with the early experimental works of the gestalt tests in Germany e.g. Dunke (1935) to date, researchers have realized that problem-solving process differ across knowledge domain and level of expertise (sternberg,1995), hence, findings obtained in laboratories cannot be generalized without caution.

However, problem-solving is a basic skill needed by today's learners. Jamie (2008), writing on the need to teach problem solving explained that changing professional standards, workplace demands, changing learning theories, new technologies trainers & educators all demand integrated learning environment which encourages the learner to use higher order thinking skills; and in particular problem-solving skills.

Educators have argued that divorce of content from application has adversely affected education system. Hebert (1996) stressed that learners learn facts and role procedures with few ties to the context and application of knowledge. Problem-solving has become the means of rejoining content and application. The need for learners to become successful problem-solvers has become a dominant theme in many developing countries. In nigeria, for instance, the poor performances of students in mathematics in public examinations have become a major concern in the country.

Problem-solving is not a distinct method of solving particular mathematics problems, rather a process that should permeate all topics in mathematics and further mathematics. American national council of teachers of mathematics in 1989 argued that learners of all ages lacked necessary basic literacy skills as well as higher order thinking skills and therefore made recommendations that students be educated to meet workplace needs. This took effect from 1991 when students began to learn content while solving realistic problem using problem-solving models. With scientific knowledge doubling every 5.5 years (nash, 1994), it

becomes increasingly important for students to develop higher order thinking skills. There are similarities and differences between the two problem-solving models of interest (krulik and rudnick's, and rubenstein's) considered in this study. These are as shown in table 1.

Table1: differences and similarities in the problem- solving models

	KRULIK AND RUDNICK	RUBENSTEIN
Differences	This has 5 stages of problem solving	The model has 4 stages
Awareness	Students read problems on their own	Students search for relationship between elements in the problem
Understanding	Students explore the problems for possible ways of solution	Incubation stage, students stay quiet, read the problem again to analyze ways for solution
Comprehension	Students select a strategy to solve the problem while the teacher goes round to just guide their choice	Teacher comes in at this stage to inspire the students to think by asking leading questions
Analysis / implementation	Students on their own use their methods to solve the problems	----------
Evaluation	Students look back and check procedures to make necessary corrections	Students verify if they get stuck, to listen to others and teacher to correct their mistakes
	This is students centered	Students are left alone initially until stage 3 where the teacher is expected to come in to inspire students
	Students are almost left alone through out the problem-solving experience, to "struggle" on their own	Greater guidance is provided to the students, relatively.

Problem-solving instruction is likely to be more effective when it is provided in a systematic manner under the direction of a teacher and students' problem-solving skills improve when they attempt to solve a variety of problems on regular basis over a prolonged period of time. These phases are simply guides not Algorithms. Algorithms are special methods specially designed for solving a particular Mathematics problem, e.g. solving quadratic equation by formula method.

Background of Study

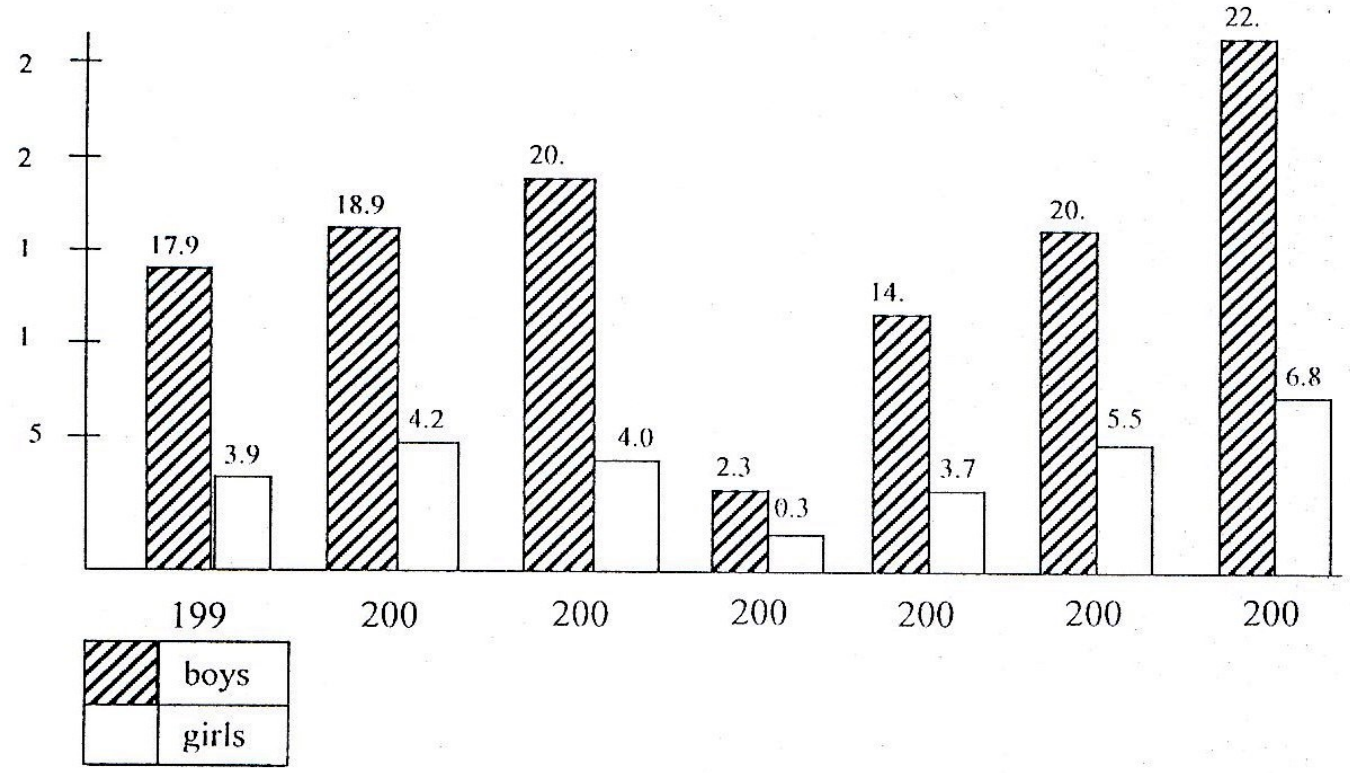
Ali (1986) highlighted that there exist problems in teaching and learning of mathematics even to the teachers of mathematics in our secondary schools. Supporting this fact, Obodo (1993) stated that mathematics teachers at all levels of education find it difficult and uninteresting to teach for so many reasons.

The reason given by the WAEC Chief Examiner in his report for year 2001 was that teaching method contributed greatly to students' poor performances in mathematics examinations. The methods usually adopted by teachers seem not to make students problem solvers. The problem of poor quality of teaching method in mathematics can be minimized if teachers are well equipped with various types of problem -solving models.

Statement of Problems

In recent years, research on students' achievement in mathematics has been the concern of many researchers in Nigeria. Ogunkunle (2007) referred to researchers like Lassa (1994), Ojo (1986) and Steen (2003) as having documented students' poor achievement in mathematics. Outside the country, the concern is the same as indicated by Oakes (1990), Leder (1992), and Fennema and hart (1994). Based on Balogun's(1994) findings, most of these findings have been in general mathematics. Little or no attention has been given to further mathematics in spite

of the fact that it is one of the basic foundation subjects for preparing scientists, technicians, engineers and Mathematicians for national development. One of the researches conducted in further mathematics was by maduabum and odili (2007). They looked into the trend of performance of boys and girls in further mathematics over a period of seven (7) years in nigeria. Their finding is represented graphically on a bar chart shown in figure 1



Year of examination

Figure 1

Bar chart of percentages of candidates who passed at credit level and above in may/june further mathematics (1999 –2005)

This trend is disturbing. Adding the performances of both sexes for each year, none is up to 30% pass at credit level. If this trend continues, the effect on women in science, technology and mathematics will be negative on the society.

This research was set out to teach further mathematics topics with problem solving models and to see if there was going to be improvement in the performance of students and also discover if boys will perform better than girls?

Purpose of Study

The purpose of this study was to investigate the relative effectiveness of the following problem solving models (Krulik & Rudnick's, and Rubenstein's) in facilitating students; performance in further mathematics to as against Algorithm.

Objectives of the study

Specifically, objectives of the Study included, to:

(1) Determine the relative effectiveness of the problem solving models over algorithm in enhancing students' performance in further mathematics.

(2) Determine the problem solving model which is most facilitative in enhancing students' performance in further mathematics.

(3) compare the performance of male and female students taught using problem solving models.

(4) Determine the joint effect of problem- solving models and gender on students' performance in further mathematics.

Research Questions

This research was guided by the following research questions:-

(1) What is the relative effectiveness of the problem-solving models over an algorithm in enhancing students' performance in further mathematics?

(2) Which of these problem-solving models is most facilitative with respect to the enhancement of student's performance in further mathematics?

(3) What difference exists between male and female students taught further mathematics using problem-solving models?

(4) What is the joint effect of problem-solving models and gender on student's performance in further mathematics?

Hypotheses

The null hypotheses tested in the study were:

Ho_1 there is no significant difference in the facilitative effect of the problem -solving models over an algorithm in enhancing students' performance in further mathematics.

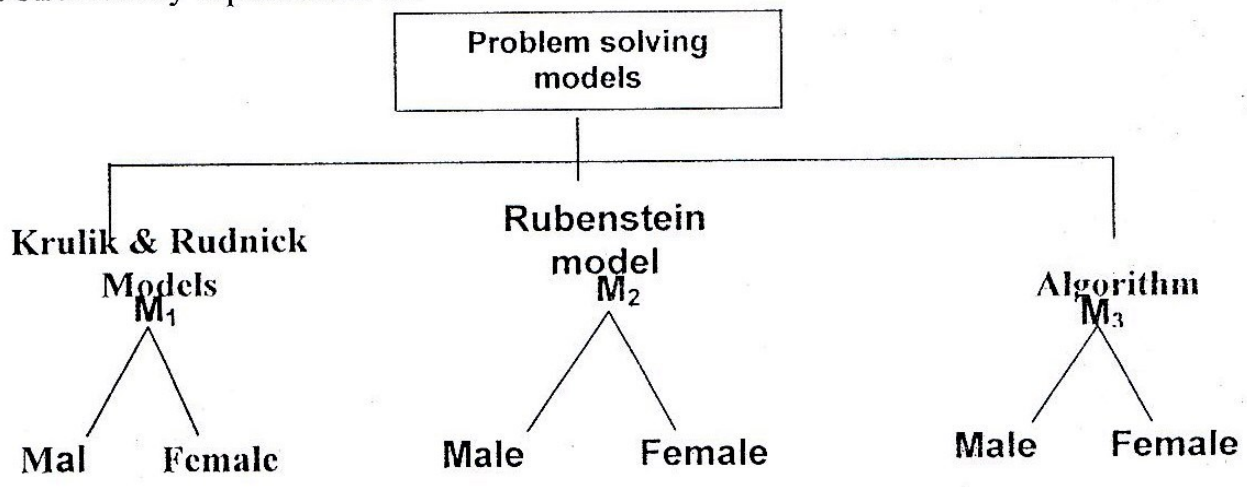
Ho_2 there is no significant difference in the performance of male and female student taught further mathematics using problem - solving models.

Ho_3 there is no significant joint effect of problem - solving model and gender on students' performance in further mathematics.

Research Method

Being a quasi - experimental research, a pretest post test control group design was used with factorial arrangement.

This is structurally represented as:



There are three groups with two experimental and one control. This design was chosen because it allowed for the use of intact classes and easily controls the reactive effects of experimentation.

Table 2:- non randomized groups pretest-post test design

GROUPS	PRETEST	TREATMENTS	POST TEST
EXPERIMENTAL 1	**Y_1**	**X_1**	**Y4**
2	**Y_2**	**X_2**	**Y5**
CONTROL	**Y3**	**X3**	**Y6**

The independent variables are the teaching models while the dependent variable is the students' performance. Sex is an intervening variable.

The Population of Study

The population of this study consisted of all senior secondary school two (SS2) students in 20 government approved secondary schools in Port Harcourt Metropolis offering further mathematics at WASSCE level for the past 5 years. Approximately 1000 students constituted the population of this study (rivers state ministry of ministry of education, 2005).

Sample and Sampling Technique

The schools were State Government - owned Co-Education Secondary schools; randomly selected from the 20 Secondary Schools in Port Harcourt by balloting. They included: -

1. Community Secondary School, Okoronodo, Rumokoro Port Harcourt.
2. Community Secondary School, Nkpolu Mile 3, Port Harcourt.
3. Community Comprehensive Secondary school, Rumukwrushi, Port Harcourt.

These schools are, day schools and teachers have been trained to the required national standard of the least national certificate of education (NCE). These have the same syllabus and all the students have passed the Junior Secondary School

Certificate Examinations. The sample comprised of 35 boys and 25 girls from each school.

Research Instruments

Teacher- made further mathematics problem solving ability test (FMPSAT) was used to gather data for the study. It was adapted from a ten year SSCE/NECO past questions. It contained forty (40) multiple choice questions specifically testing the ability to solve problems on combination, Permutation & Pascal Triangle.

It was carefully constructed using a lesson plan and a test blue print based on the specific objectives of the lesson plan. Since all the instruments were teacher- made, they were trial-tested using a group of 25 students from Amadi-Ama Community Secondary School, Amadi-Ama, a subset of the population not part of the research. The students were pretested and after a week, were taught and post

tested, this helped to calculate the reliability of the test. Item analysis was also carried out to determine the difficulty and discrimination indices.

Some items whose indices were either too high or too low were modified. Validity of instrument to ascertain the validity of the instruments, the test items were drawn from a test blue print based on the specific objectives of the lesson plan. Face validity and content appropriateness was judged by the research supervisor and other experts in mathematics educators. Item analysis was also carried out.

Reliability of Instrument

This was computed using a trial test group of 25 students from Community Secondary School, Amadi-Ama, Port Harcourt, a subset of the population but not part of the research. Using Kuder Richardson formula – 21, the reliability of pretest is 0.84 & reliability of posttest was 0.96.

Teaching Method

The experimental groups were taught using the lesson plans with problem - solving models at different lesson times by the researcher. FMPSAT was administered as the pretest for the students one week before teaching took place in all the schools. This helped the researcher to determine the equivalence of the groups. After the teaching, FMPSAT was administered as the posttest. The control group was taught using the algorithm lesson plan.

Data Analysis

Data generated in the study were analyzed using a 3 x 2 factorial analysis of variance. Scheffe's Post Hoc Test was used to check for the particular pair with significance (howel, 2002; nwankwo, 2006; and onwioduokit, 2000).

Results

To answer the research questions and test the hypotheses, the results are presented in tables.

Table 3: post test means scores for all the groups.

		Algorithm (Sch. 3)	Krulik & Rudnik (Sch. 1)	Rubenstein (Sch. 2)	TOTAL
Boys N=35	ΣY =	472	788	958	2218 (n=105)
	ΣY^2 =	6193	20841	20094	47128
	Y =	13.5	22.5	27.4	21.1
Girls N=25	ΣY =	190	488	661	1339 (n=75)
	ΣY^2 =	1532	10718	18623	30873
	Y =	7.6	19.5	26.4	17.8
Total N=60	ΣY =	662	1276	1619	3557 (180)
	ΣY^2 =	7725	31559	46717	86001
	Y	11.03	21.3	27.0	19.8
	SD=	2.67	8.9	7.2	6.3

Table 4 'summary of 3 x 2 factorial analysis of variance of students' performances in the experimental and control groups.

SOURCE	D f	Ss	Ms	F CRITICAL VALUE	VALUE	DECISION ON AT P<0.05
S (SEX) **BETWEEN GROUP**	1	477.45	477.45	11.8 3.90		*
M (mETHOD)	2	7859.40	3929.7	96.1 3.05		*
Sxm (interraction)	2	141.25	70.63	1.73 3.05		
Error **(WITHIN GROUP)**	177	7232.60	40.9			
Total	179	15710.7				

*=significant at p <0.05

The calculated f- value for sex is greater than the critical value. Also, the calculated f-ratio for method is greater than the critical f- value while the interaction between sex and method is less than the critical value. This implies that both sex and methods have significant effects on the performance of students in mathematics. Table 4 further shows that the interaction between sex and methods is insignificant.

Table 5: scheffe post hoc analysis

Compared Groups	Compared f- Values	Critical Values	Decision P∠0.05
1 and 2	6.69	3.03	*
1 and 3	16.30	3.03	*
2 and 3	39.41	3.03	*

As seen in table 5, Rubenstein Model was found to be most facilitative seconded by Krulik and Rudnic Model. Algorithm was however found least facilitative.

Table 6: summary of main effects of the analysis of variance of students'scores in the experimental and the control group.

Source	Df	SS	MS	F value	critical value	Level of significance
Methods with						P<0.05
Boys	2	3479.35	1739.68	35.84	(2.41)	*
Girls	2	4522.25	2261.13	46.58	(2.41)	*
Sex with						
Kulak & Rudnick	1	131.4	131.4	2.71	(3.90)	NS
Rubenstein	1	14.6	14.6	0.30	(3.90)	NS
Algorithm	1	607.5	607.5	12.52	(3.90)	*
Error(within groups)	290	14075.69	48.54			

***= SIGNIFICANT, NS= NOT SIGNIFICANT**

The Calculated F- Values for all the Methods for Boys and for girls are higher than the critical values. this implies significant effects of methods on both sexes.

Secondly, the calculated F- values in both sexes for Kulak/Rudnick models and Rubenstein were smaller than the critical value. This implies that male and female students do not differ significantly in their performances based on the two models. The table further shows that when Algorithm was used, male and female students differed significantly.

Research Question 1

What is the relative effectiveness of problem - solving models over an algorithm in enhancing the students' performance in further mathematics?

From table 3, the experimental group 1 had a total means of 21.3; group 2 had 27.0, while the algorithm group had 11.03. This shows that both Rubenstein and Kulak/Rudnik models are relatively more effective than the algorithm.

Research Question 2

Which of these problem-solving models is most facilitative in respect to the performance of students in further mathematics?

From tables 4 and 5, it is seen that Rubenstein Model was found most facilitative of the three models, followed by kulak in enhancing Students' Performance in further mathematics.

Research question 3

What difference exists between the male and female students taught further mathematics using problem-solving model?

Comparing the means from table 3, Krulik and Rudnick boys had 22.5 while girls had 19.5 while Rubenstein boys had 27.4 and the girls had 26.4.looking at the overall mean for problem- solving models, boys had 21.1 while girls had 17.8. This implies that differences exist between the performances of boys and girls with the former performing better than the latter.

Research Question 4

What is the joint effect of problem solving and gender on students' performance in further mathematics?

As shown in table 4, the interaction of the problem-solving models with sex was not found significant. Hence, the models used have no joint effect with sex on students' performance in further mathematics.

Hypotheses Testing

Hypotheses 1

There is no significant difference in the facilitative effect of the problem-solving models with respect to the performance of students in further mathematics.

Analysis of data shown in Tables 4 and 5 has shown that there exists a significant difference in the facilitative strength of the three models in enhancing students' performance. Hence, the null hypothesis is rejected.

Hypothesis 2

Null hypothesis (HO2): there is no significant difference in the performances of male and female students taught further mathematics using problem-solving models.

Data analyzed as shown in Table 6 portray the fact that problem –solving model as a whole had significant effects on the performances of male and female

students in further mathematics. However, the table further showed that except for Algorithm, no model used in the study significantly impacted male and female students differently with respect to their performance in further mathematics.

Hypothesis 3

Null hypothesis (HO3): there is no significant joint effect of problem solving and gender on students' performance in further mathematics.

Table 4 shows the analysis of interaction of problem- solving model and sex. It can be seen from the table that the interaction effect of these factors is not significant. Thus the null hypothesis is upheld. This implies that the effect of one factor on all levels of the other is the same.

Discussion of Findings

The result of this study revealed a relative increase in the means scores of students taught with the problem -solving models over the algorithm. This is perhaps because problem- solving models are higher order cognitive processes needed to solve further mathematics problem. This finding is in agreement with gold and Levin (1987) who observed that problem-solving techniques aid high comprehension of abstract facts which is embedded in mathematics. Only the algorithm, of course, cannot easily achieve this.

The most facilitative model in respect to the performance of students in further mathematics is the Rubenstein Model. It was followed by Krulik and Rudnick. This is in agreement with Alfred (2008).

This study also exposed the fact that boys will do better than girls if not taught with proper problem solving models. This is supported by Alyedun (2000) and Nwachukwu (2003) who also obtained that that there is no significant difference in the performance of boys and girls in mathematics. This proven that girls are equally likely to perform well in further mathematics if taught with adequate methods.

The lack of significant joint effect of problem-solving and gender on students' performance in further mathematics supports by Odili (2006), Gurd and Christopher (2007).

Initially, the three groups were analyzed (algorithm, inclusive).the outcome showed that sex was significant. This finding agreed with a number of researchers such as Maduabum with Odili (2007), hart (1994) and Leder (1992) who said that boys do better than girls in mathematics and further mathematics achievements. But when post hoc test was conducted, the differences that existed were insignificant. This means that the teacher should go beyond using the ordinary method in teaching particular topics in secondary schools, if not, there will be gender disparity in the class.

Conclusion

The major finding of the study is that those taught with problem- solving models performed better than those taught with Algorithm. Teachers should therefore search for models that can facilitate different topics in the teaching of further mathematics. Equally important is the finding that the differences in the performances of boys and girls were insignificant using each problem-solving model. It was on with Algorithm that a difference as found. Thus, girls should be encouraged to ignore the popular idea that further mathematics is for male students.

Implications of the findings:

The findings of this research have implications for the students, teachers, curriculum planners and the government.

1. No girl should hide under the belief that further mathematics is meant for males. Girls are as capable as boys in further mathematics.

2. Teacher should employ the use of different problem -solving models in teaching different topics in further mathematics since it has been established that they have potentials of improving students' performance.

3. For curriculum planners, policy makers and the government mathematics teachers allowance should be reasonable. This will motivate the teacher and enable him/her spend more time in search of the best method to use to teach the students rather than being a bird of passage.

Recommendations

Considering the problems identified in this study and the benefits derived from the use of models, some recommendations are being made.

The further mathematics teacher should always use appropriate Problem -solving model in teaching. On the part of school administrator, mathematics club should be formed to organize drama, mathematics day, mathematics house competitions etc. facilitators should be invited from higher institution to speak to students on such special days on the importance of further mathematics.

Finally, Teacher should be financed to attend seminars, and workshops on models. This will help eradicate the teaching of mathematics with tears and expose them to a wide range of heuristic models, which can facilitate the teaching of further mathematics.

Suggestion for Further Research

In the light of the finding and conclusion drawn, the following suggestions for further

Study are Made:

1. This study can be carried out in other places for cross validation.
2. Other variables like students' interest, reasoning ability, among others, can be included in the study.
1. Further studies can be extended to the use of different models on different further mathematics concepts.

References

Adaramola, M. O. (2006). Effect of Mathematical games on students' performance and attitude in Mathematics. An unpublished (M. Ed) thesis submitted to faulty of Education, Rivers State University of science and Technology. Port Harcourt.

Adetunla, L. O. (1987). Improving the teaching of Problem Solving Abilities in Schools. Paper represented at the International Conference / Workshop on Mathematics Applications, Zaria.

Alamina J. I. (2001) .Fundamental principles of science teaching and learning. Port Harcourt: *Votex Publishers*.

Alele Williams C. (1986) Education of women for national development. A paper delivered at workshop on women Education in Nigeria. Lagos.

Alio, BC and Harbor peters V.F (2007). The effect of Polya's problem solving techniques on Secondary School Students achievement in mathematics. *Abacus, the Journal of mathematics association of Nigeria 25(1) 27-39.*

Ali A.A (1986) .A handbook of methods for secondary schools science teachers and unpublished handbook.

Ali (1989). Content Competence: Mathematics attained by grade 2 teachers for teaching primary school management. *Journal of Education Studies*. (2)28-43.

Allocca, & Muth, R. (1982). School Culture and Academic Achievement: A cross gender, cross cultural study. ERIC 1982 – June 1993 MF 01/PC02.

American Council of Supervisors of Mathematics (1978). Position Paper On Basic Mathematical Skills. *Mathematics Teacher*, 71 (2), 147 – 52

American National Council of Teachers of Mathematics (1989). Curriculum and evaluation standard for school mathematics. Retrieved from

http://www.plato.com/download/papers/parerno4pdf on 20th September 2008.

Anzai, K and Simon, H.A. (1979) .The theory of learning by doing: Psychological review 86. Retrieved from **http://enwikipedia.org/wiki/problemsolving on 20th September 2008**.

Aiyedun, J. O (2000) .Influence of sex Difference of students on their achievement in Secondary school mathematics. *Abacus; Journal of the Mathematics Association of Nigeria 25 (1) 102 – 113.*

Balogun T. A. (1994) .Gender issues in the teaching of science, technology and Mathematics. In S. Y. Erinosho (Ed) *Perspectives on Women in Science & Technology in Nigeria*. Ibadan: Sam Bookman Educational and Communication services.

Baribor V (2003) Learning theories and instructional process Springfield Publishers (Ltd) New Owerri.

Blass, A. & Yuri G. (2003). Algorithms: A quest for Absolute Definitions. Bulleting of European Association for theoretical Computer Science. Retrieved from **http://enwikipedia.org/wikipedia.org./wiki/algorithm on 20th Sept 2008**.

Burgin, M. (2005). Super-Recursive Algorithm; Monographs in Computer Science; Springer. ISBN 0387955690. Retrieved from **http://www.enwikipedia.org/wiki/algorithm on 20th Sept. 08**.

Crews D. (2000) .Introduction to problem solving. *Educational Researcher* 25(4) 12 – 21Retrieved on the 20th September 2008 from **http://www.querhs.k12.nf.calproject/Mathematicsproblems/introduction/html**

Czitrom V. (1999) .One Factor at a time versus designed experiments, American Statistician, 53, 126 – 131.

Ezeife (1991). Refresher courses in teacher's education: The Nigerian experience.

Federal Ministry of Education (1985) .Further Mathematics Curriculum for Senior Secondary Schools: Lagos. Government Press,

Federal Republic of Nigeria (1998). the national policy on education

Fennema & Hart, L. (1994). Gender and the JRME. *Journal for Research in Mathematics Education, 25 (6) 648 – 659.*

Garafalo, J. & Lester, F. (1985) .Metacognition, Cognitive monitoring and Mathematical performance. *Journal for research in Mathematics Education* 16 (3) 63 – 76

Gerd, G. and Christoph E. (2007) .Heuristics and the Law, Cambridge, the MIT press Retrieved from **http://www.wikipedia.org/wiki/heuristic** on 20th Sept. 2008

Goldstein, F. C. & Levin, H. S. (1987). Disorders of reasoning and problem solving ability. In M. Meier A Benton & L. Diller (Eds) Neuropsychological Rehabitation. London: Taylor & Francis Group

retrieved from **http://www.wikipedia.org/wiki/problem** solving on 20th Sept. 2008.

Harbor Peter (2001). Mathematics as a tool for UBE: Implication to the society; Proceedings of the Annual conference of Mathematics association of Nigeria (MAN) 101 – 107

Hiebert, J . (1996). Problem solving as a basis for reform in curriculum Instruction: The case of mathematics. *Educational Researcher* 25 (4) 12 – 2I

Howel, d .c (2002). statistical mathods for psychology; 5th edition; belmount/wadsworth publishers, U.S.A.

Ibrahim, G. (2004) .The state of further mathematics curriculum in secondary schools in Sokoto and Zamfara state. *Abacus. A journal of MAN.* 29(1)24-28.

Igbokwe (1997) .Teachers performance in mathematics content area poorly by primary school pupils. *Journal of Science Teachers Association of Nigeria. (STAN) 32(1)10-20.*

Jamie, k. (2008). The Need to teach problem soling retrieved from **http://www.plato.com/downloads/papers.pdf on Sept. 20**, 2008

Kleen, C. S. (1943) .Recursive Predicates and Quantifiers. "American mathematics Society trans actions Vol. 54; 1 reprinted as Church Thesis Mkleen 1952. **http://www.enwikipedia.org/wiki/algorithm** on 20th Sept. 08.

Lacombe, T. (1985). Mathematics learning difficulties in secondary school pupil's needs and fides.

Leder, G. C. (1920) Mathematics and gender: Changing Perspectives in D. A. Grouws (Ed) Handbook for research on Mathematics teaching and learning. New York: Macmillan.

Lester, F.K. (1980). Problem Solving: Is It A Problem? In M.M. Lindquist (Ed) Selected Issues In Mathematics Education (Pp. 29-45) Berkeley, Ca: Mccutchan Publishing Corporation.

Maduabum, M. A. and Odili G. O. (2007). Trend in Gender Performance in Further Mathematics in Nigeria: A survey. ABACUS: *The Journal of the Mathematics Association of Nigeria 32 (1) 115 – 123.*

Mayer, R.E. & Hegarty, M. (1996). The process of understanding mathematical Problems. In R.J. Stemberg, T. Ben-Zeev (Eds). The nature of mathematical Thinking. (pp. 29-53) Mahwah, NJ: Lawrence Erlbaum Associates.

Nash, D. A. (1994). The Lifelong Learning Imperative ... Ends and means. *Journal of Dental Education 58 (10) 7855 – 790*

Nwachukwu C. I. (2003). A comparative study of male and female students achievement in Mathematics and science. A Nigeria Perspective In C. Ekpo (Ed) Strategies for effective teaching and learning of science, technolog

and mathematics (STM) Education: A book of reading (pp 28 – 36). Uyo: Institute of Education Publication.

Nwankwo , O. C.(2006). A practical guide to research writing. Revised edition; Enugu.Ferdinco publishers.

Oakes J. C. (1990) .Opportunities, Achievement and Choice: Women and Minority Students in Science and Mathematics. *Review of research in Education. 16, 153 – 222*

Obioma, G. O. & Ohuche R. O. (1980). Sex and Environment as Factors in Secondary school mathematics achievement. *Journal of the mathematics Association of Nigeria 15,33 – 39.*

Obioma, G. O. (1992) The Philosophy and Instruction of Mathematical Games, A working Paper Presented at the workshop on the Development of Prototype Mathematics Games; Organized by National mathematics centre (NMC) Abuja.

Obodo G.C (1993) Engineering effective solutions to science and mathematics education in Nigeria. A preview in Obodo G. C. (ed) science and mathematics education in Nigeria NSUKKA: "The Academic Indent".

Odili G.A. (2006). Mathematics in Nigerian secondary schools. A teaching perspective Lagos. Anachuna Educational Books.

Ogunkule R. A. (2007) .Effect of Gender on the Mathematics achievement of students in Constructivist and non- constructivist groups in secondary schools. *ABACUS – A Journal of Mathematics Ass. Of Nigeria. 32 (1) 41 – 48.*

Ojo, M. O. (1990) "Maximizing students; learning of Mathematics through students interaction patterns. A paper presented at the 28th Annual Conference of MAN held at ABU Bauchi, Sept 3rd – 7th.

Onwioduokit , F. A.(2000). Educational Research Methodology and Statistics. Uyo: Dorand Publishers

Polya G (1945) How to solve it. A new aspect of mathematical method, Princeton, NJ: Princeton University Press. Retrieved from **http://en.wikipedia,org/wiki/heuristic. on 20th September 2008**.

Silver, E.A. (1987). Founders of cognitive theory and research for mathematics Problem solving. In A.H. Schoenfeld. Cognitive science and mathematics Education (pp. 33-60). Hillsdale, NJ: Lawrence Erlbaum Associates

Sipser, M. (2006) Introduction to the theory of computation. P. W. S. publishing Company. Retrieved **http://www.enwikipedia.org/wiki/algorithm** on 20th Sept. 2008.

soyemi, b. o. (2003) students dictionary educare foundation projects in collaboration with os and associates limited- publishers' text and leisure publishers co nig.

Stephen, N. E., Thomas, R. K., Joan, L. C. and John F. T. (2001) Education Psychology: Effective teaching, Effective Learning. (3rd Ed.) MC Graw Hill: New York.

Wayne R (1995) Faces or mathematics 3rd edition, New York, U.S.A. Herper Collins College publishers.

Wilson, J.W. Fermandez, M.L. & Hadaway, N. (1993). Mathematical problem Solving. In P.S. Wilson (Ed), Research ideas of the classroom: High School mathematics (pp 57-78). New York, NY: National Council of Teachers of Mathematics.