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STATISTICAL ANALYSIS ON EXTENT OF METACOGNITIVE STRATEGIES USAGE IN TEACHING SECONDARY SCHOOL MATHEMATICS

Ijeoma Eberechukwu Okechukwu PhD and Olukemi Bisola Olufemi-Ojo

DEPARTMENT OF STATISTICS FEDERAL POLYTECHNIC OKO

Okechukwuijeoma41@gmail.com

08060256823

Abstract

The fact that students consistently fail mathematics has necessitated the need to review strategies teachers are using in teaching mathematics. Metacognitive strategies are sequential processes individuals use to learn, control themselves and to reach a goal. Metacognitive strategies have been acclaimed by many for its effectiveness in increasing students' performances in learning generally. The study assessed extent of use of Metacognitive strategies in teaching secondary school Mathematics in Anambra State. Three research questions and three hypotheses guided the study. A sample of 73 Mathematics teachers from four Education Zones was selected using multi-stage sampling technique. The TMSAI (Teachers Metacognitive Strategies Awareness Inventory) was used to collect the required data. The data were analyzed using mean and standard deviation to answer the research questions while the null hypotheses were tested using Analysis of Variance (ANOVA) and Main- Whitney U test. The major findings revealed that use of metacognitive strategies by mathematics teachers is not influenced by: i school location ii years of teaching experience. iii gender.iv school location. Based on the findings from the results, recommendations were made which include: (i) Teachers should avail themselves the opportunities of online learning. (ii)In service training should be organized by the relevant agencies such as Science Teachers Association of Nigeria (STAN), Mathematical Association of Nigeria (MAN) and others. (iii) Curriculum upgrading for pre service teachers should include teaching of metacognitive strategies explicitly. Finally suggestions were given for further research on Metacognitive strategies.

Key words: metacognition, metacognitive strategies, mathematics, gender.

INTRODUCTION

Mathematics is an intellectually stimulating subject that affects every aspect of human activity, such as politics, economy, science and Technology. It is a gate way subject to tertiary institutions. Mathematics is an indispensable partner in scientific development and progress of any nation. No wonder Salman (2005) described mathematics as a precursor of scientific discoveries and intervention. The learning of mathematics has become so important in every society, if citizens are to cope with the fast changing scientific and Technological development in the 21st century. One is expected to obtain at least a credit pass in mathematics at the Senior Secondary School Examination (SSCE) before proceeding for further studies in any tertiary institution in Nigeria and beyond. As a result of the importance of mathematics

to national development, the Federal Government of Nigeria (FGN, 2013) included mathematics as a compulsory subject for every child of school age so as to acquire appropriate mathematical skills that will enable him/her copy with life challenges.

Despite the importance of mathematics to nation building, students and teachers efforts to cover the syllabus, students have continuously performed poorly both in internal and external examination. The causes of poor performances of students in senior secondary school mathematics have been attributed on so many factors, So many researchers have attributed students poor performances to poor teaching method, lack of qualified and experienced mathematics teachers, poor infrastructure and lack of facilities etc (Peter, 2001; Njoku, 2004; Falaranmi, 2002; Ogunkunle, 2004; Agu, 2005.)

The persistent poor performance of students in mathematics has necessitated the call by the Chief Examiner (2006), for a review in the instructional strategies used in the teaching of mathematics. The clamouring for a review in instructional strategies used in teaching science and mathematics has resulted in the recent innovative strategies that have been going on in Science education. Among such innovative strategies are metacognitive strategies which have be described by many researchers as effective tools in enhancing students performances in science. Teaching metacognitive strategies is a potentially new goal for science teachers and mathematics teachers are not left out. Researchers show that metacognitive strategies can be taught to student to improve their learning (Thiede, Anderson & Therriault, 2003; Nietfeld & Shraw, 2002). According to Wichadee (2011), Metacognitive strategies are effective tools which help learners to be consciously aware of what they have learnt and recognizing situations in which it could be useful. Metacognitive strategies are memorable plan of actions that provide students easy to follow procedure for solving a particular mathematics problem.

Studies on study strategies have shown that students acquire "learning how to learn skills" through trial and error without formal training or guidance. As a result not all students can learn effectively in the class, some students are unable to identify, the best way to approach mathematics problems. They just follow whatever activities teachers have planned for them. Teachers rarely, if ever demonstrated to their learners exactly what learning how to learn means, the meaning of thinking about one's own thinking, and how to become a problem solver. Instead, the message sent out consistently has been the following, the right answer according to the right method first. It is quite clear that most students follow a recipe without appropriate insight into the nature of problem solving or how to solve mathematics problems. (Saemah & Hayati, 2009; Chi & Vanleh, 2010;).

Most studies have documented that learning how to learn is not an agenda in most classroom settings. Students are not aware of thinking process that occurs during learning. Student should be taught not only the content but also the learning strategies; they need to understand the content. Infact students are supposed to be taught metacognitive strategies. Constructing understanding requires both cognitive and metacognitive strategies. Learners "construct knowledge" using cognitive strategies and they guide, regulate and evaluate their learning using metacognitive strategies. It is through this thinking about thinking, this use of metacognitive strategies that real learning occurs. As students become more skilled at using metacognitive strategies, they gain confidence and become more independent as learners so metacognitive strategies should to taught explicitly. (Joseph, 2010, Saemah & Hayati, 2009; Woolfork, 2008).

According to Aydin (2011) one of the main goals of education is to make the students gain the thinking skills and strategies which they will use throughout their lives, rather than storing information. There is a challenge facing us, how to make sure that what researchers and theorists have learnt about metacognition and its dual roles, teaching with metacognition (reflection on goals, students characteristics, content etc) and teaching for metacognition (how to activate and develop metacognition in students) has impact on standard classroom practice in Nigeria and Anambra in particular.

STATEMENT OF THE PROBLEM

Teaching metacognitive strategies is a potentially new goal for science and mathematics teachers. A lot of researches conducted abroad have recorded significant findings in the use of metacognitive strategies in learning, little or nothing has been recorded about mathematics teachers in the Nigerian context. This then necessitated these questions; are mathematics teachers in Anambra State teaching metacognitive strategies? Do they teach for metacognition? To what extent do they teach with metacognition? It is therefore imperative to investigate the extent metacognitive strategies are been implemented in standard classrooms in Anambra State. Hence the need to evaluate secondary school teachers use of metacognitive strategies in teaching mathematics in Anambra State.

PURPOSE OF THE STUDY

The objective of the study is to determine the extent of metacognitive strategies usage in teaching mathematics in Anambra State. Specifically, this study sought to:

1. Determine extent of metacognitive strategies usage among secondary school mathematics teachers in Anambra State.
2. Determine whether teachers' years of experience affect the use of metacognitive strategies among secondary school mathematics teachers in Anambra state.
3. Examine effect of gender on the use of metacognitive strategies among secondary school mathematics teachers in Anambra state.

RESEARCH QUESTIONS

1. What is the extent of metacognitive strategies usage among secondary school mathematics teachers across four Education Zones in Anambra State?
2. What is the correlation between teachers' years of experience and the use of metacognitive strategies?
3. What is the effect of gender on the use of metacognitive strategies among secondary school mathematics teachers?

RESEARCH HYPOTHESES

1. There is no significant difference between the mean ratings of mathematics teachers' use of metacognitive strategies based on school location.
2. There is no significant difference in the mean ratings of teachers with regards to their use of metacognitive strategies and years of teaching experience.
3. There is no significant difference between mean ratings of male and female teachers in the use of metacognitive strategies.

METHODOLOGY

The study adopted the descriptive survey design since the result from the sample will be generalized on the entire population of Mathematics teachers in Anambra State. The areas covered by the study were four Education Zones out of the Six Education Zones in the State, namely Awka ,Aguata, Onitsha and Ogidi Education Zones. There are 289 mathematics teachers in the 179 secondary schools in the four Education Zones selected for the study. A multistage sampling procedure was used to select 73 teachers, 50 female and 23 male teachers who supplied the data. The first stage involved simple random sampling in selection of four Education Zones out of the six Education Zones in Anambra state. In the second stage, purposive sampling was used in selecting only 130 schools with mathematics teachers.At the third stage, proportionate random sampling technique was used for selecting schools with mathematics teachers that were used for the study, 20% of the 130 schools with mathematics teachers in the four selected zones were sampled. This gave a sample of seven schools from Aguata zone, 10 schools from Awka zone, 4 schools from Ogidi zone and finally 5 schools from Onitsha zone respectively. In the final stage, simple random sampling technique was then used in all the four selected zones, so as to get the names of schools to be used in the study. In all, a total of 26 schools were selected for the study. The distribution of mathematics teachers in the schools selected are as follow: Awka Zone has 18 female teachers and six male teachers .Ogidi Zone has six female teachers and four male teachers. Aguata Zone has ten female teachers and six male teachers. Finally Onitsha Zone has 16 female teachers and seven male teachers. This gave a sample size of 73 teachers.50 female teachers and 23 male teachers' altogether. The instrument for data collection is a Teachers' Metacognitive Strategies Awareness Inventory (TMSAI) developed by the researcher. The TMSAI is divided into two sections. Section A is for personal information regarding the respondent. And Section B is a list of 33 statements to determine use of metacognitive strategies. The items were structured on a 5-point rating scale of Always (5pts), Often (4pts), Sometimes (3pts), Rarely (2pt), Never (1pt). There is no right or wrong answers in this list of statements. It's simply a matter of what is true for each respondent. Some statements are about teachers ideas in relation to students in general and some about teachers themselves. The instrument was validated by two lecturers from Science Education Department, Nnamdi Azikiwe University, Awka. The research questions, purpose of study, statement of the problem and hypotheses were used in vetting the items in terms of relevance to the subject matter, coverage of the content area, suitability of language and clarity of purpose. The instrument was administered to 20 mathematics teachers in Nnewi Education Zone of Anambra State who were not used for the study and their responses were analyzed using Cronbach Alpha technique which yielded coefficient of internal consistency of 0.89. For each respondent, total TMSAI scores were generated, the data obtained from the study were analyzed using different

statistical tools. To answer the research questions, mean and standard derivation were used while Mann-Whitney U-test and Analysis of Variance (ANOVA) were employed to test the hypotheses. Mann-Whitney U test was used for hypothesis three. Mann-Whitney U-test was used because some schools in the population did not have mathematics teachers which is not what is expected in a normally distributed population. Finally, ANOVA was used for testing hypotheses one and two

Results

Research Question 1

What is the extent of metacognitive strategies usage among secondary school mathematics teachers across four Educational Zones in Anambra State?

Result of this research question is shown in table 2

Table 1

Mean and SD of use of metacognitive strategies among teachers across the four Education zone.

	AWKA			AGUATA			OGIDI			ONITSHA	
	$\bar{x}$	SD	R	$\bar{x}$	SD	R	$\bar{x}$	SD	R	$\bar{x}$	SD
1	2.38	1.01	NU	2.06	0.68	NU	2.40	1.08	NU	2.60	0.88
2	2.50	0.89	NU	2.50	0.89	NU	2.60	0.84	NU	2.48	0.90
3	2.00	0.72	NU	2.00	0.73	NU	2.10	0.74	NU	1.96	0.71
4	3.17	1.68	U	2.75	1.48	NU	3.40	1.78	NU	2.96	1.63
5	2.75	0.44	NU	2.75	1.48	NU	2.80	0.42	NU	2.74	0.45
6	2.38	1.01	NU	2.06	0.68	NU	2.40	0.87	NU	2.30	0.30

7	2.50	0.89	NU	2.50	0.89	NU	2.60	0.89	NU	2.48	1.29
8	2.75	1.36	NU	3.63	1.02	U	2.90	1.28	NU	2.65	1.23
9	4.00	1.02	U	3.75	1.12	U	4.50	0.70	U	3.87	1.64
10	3.50	0.98	U	3.63	1.03	U	3.30	0.82	U	3.52	1.00
11	2.00	0.72	NU	2.00	.73	NU	2.10	0.74	NU	1.96	0.71
12	2.00	0.72	NU	2.00	0.73	NU	2.10	0.74	NU	1.96	0.71
13	3.17	1.68	U	2.75	1.48	U	2.10	0.73	NU	1.96	0.71
14	4.00	1.02	U	3.75	1.13	U	4.50	1.78	U	3.87	1.64
15	3.50	0.98	U	3.63	1.02	U	3.30	0.83	U	3.52	1.00
16	2.00	0.72	NU	2.00	0.73	NU	2.10	0.74	NU	1.96	0.71
17	2.00	0.72	NU	2.00	1.48	NU	2.10	0.74	NU	1.96	0.16
18	3.17	1.69	U	2.75	1.13	NU	3.40	1.78	U	2.96	1.64
19	3.50	1.00	U	3.75	1.03	U	4.50	0.71	U	3.87	1.10
20	4.00	1.02	U	3.63	1.03	U	2.10	0.82	NU	2.96	1.64
21	2.00	0.72	NU	2.00	0.73	NU	2.30	0.71	NU	1.96	0.71
22	2.00	0.72	NU	2.00	0.73	NU	2.10	0.71	U	1.96	0.71
23	3.17	1.69	U	2.75	1.48	NU	3.40	1.78	U	3.52	0.99
24	2.00	0.72	NU	2.00	0.73	NU	2.10	0.74	NU	1.96	0.71

25	2.75	0.45	NU	2.00	0.73	NU	2.10	0.74	NU	2.74	0.45
26	3.17	1.69	U	2.75	1.48	NU	3.40	1.78	U	3.52	0.79
27	2.00	0.72	NU	2.06	0.68	NU	2.80	0.42	NU	1.96	0.71
28	2.50	0.89	NU	2.06	0.68	NU	2.40	1.08	NU	2.74	0.45
29	2.38	1.01	NU	2.50	0.89	NU	2.60	.84	NU	2.48	0.89
30	3.50	0.98	U	3.63	1.03	U	3.30	0.83	U	3.52	0.99
31	2.00	0.72	NU	2.00	0.73	NU	2.10	0.74	NU	2.96	1.06
32	2.00	0.72	NU	2.00	7.30	NU	3.40	1.78	U	1.96	7.06
33	3.17	1.68	U	2.75	1.48	NU	3.40	1.78	U	2.96	1.64
Total	2.72	0.99	NU	2.51	1.19	NU	2.80	1.00	NU	2.69	1.12

NU (NOT USED) U (USED)

Result of Table I indicates that teachers in Awka Zone used 13 items, regularly while Aguata zone, Ogidi, and Onitsha zones recorded 9,12and 8 items respectively. The rest of the items that were below mean rating 3.00 were the items that were sparingly implemented or used by the teachers in the classrooms.

Table 2

The summary of mean and standard deviation of Mathematics teachers' use of metacognitive strategies based on school location.

ZONE	NO	$\overline{X}$	SD
Awka	24	2.74	0.710
Aguata	16	2.53	0.457

Ogidi	10	2.87	0.838
Onitsha	23	1.64	0.619
TOTAL	**73**	**2.68**	**0.649**

The mean scores of each of the zones was less than 3.00 indicating that metacognitive strategies were sparingly used across the four Education Zones.

Hypotheses 1

There is no significant difference between the mean rating of mathematics teachers' use of metacognitive strategies based on school location.

The test of this hypothesis is shown in Table 3

Table 3

The ANOVA on the use of metacognitive srtategies among secondary school mathematics teachers across four education zones.

	Sum of square	DF	Mean square	F Cal	F Cric
Between Groups	.018	3	0.006	0.74	2.74
Within Groups	5.548	69	0.080		
Total	**5.556**	**72**			

The F_{cal} is less than the F_{crit} hence the null hypothesis is accepted signifying that there is no significant difference in the extent of metacognitive strategies awareness among mathematics teacher across four Education Zones in Anambra State.

Research question two

What is the correlation between teaches' years of experience and the use of metacognitive strategies.

The results of this question is represented on Table 4

Table 4

Mean and standard deviation of teachers' years of experience and use of metacognitive strategies.

Years of Experience	N	Mean	Standard Deviation	Standard Error
0-5	5	2.7178	.68228	.30513
6-11	6	2.8311	.97184	.39675
12-17	14	2.7436	.20996	.18974
18 and above	48	2.6395	.59911	.08647
Total	**73**	**2.6806**	**.64857**	**0.7591**

From table 2 all the different groups have mean score less than 3.00 indicating that teachers in the different groups of year of experience sparingly use metacognitive strategies

Hypothesis 2

There is no significant difference in the mean rating with regards to their years of teaching experience and use of metacognitive strategies.

Table 5

One way analysis of variance of teachers' years of experience and use of metacognitive strategies.

	Sum of square	DF	Mean square	F Cal	F Cric
Between Groups	.279	3	0.06	.214	3.98
Within Groups	30.007	69	.435		
Total	**30.286**	**72**			

The null hypothesis is upheld there is no significant difference between years of teaching experience and use of metacognitive strategies.

Research question 3

What is the effect of gender on the use of metacognitive strategies among secondary school mathematics teachers?

Table 6

Mean and standard deviation of male and female mathematics teachers in the use metacognitive strategies.

Statement	Male			Female		
N/S	$\overline{X}$	SD	Remark	$\overline{X}$	SD	Remark
1	2.14	.98	NU	2.40	.86	NU
2	2.57	.84	NU	2.48	.87	NU
3	2.13	76	NU	1.94	.68	NU
4	2.91	1.44	NU	3.10	1.70	U
5	2.78	.42	NU	2.74	.44	NU
6	2.04	.98	NU	2.40	.86	NU

7	2.57	.84	NU	2.48	.87	NU
8	2.48	1.12	NU	2.52	1.30	NU
9	3.96	1.07	U	3.98	1. 68	U
10	3.57	.99	U	3.48	.95	U
11	2.13	.75	NU	1.94	.68	NU
12	2.13	.75	NU	1.94	.68	NU
13	2.19	1.44	NU	3.10	1.70	U
14	3.96	1.07	U	3.98	1.05	U
15	3.57	.99	U	3.48	.95	U
16	2.13	.76	NU	1.94	.68	NU
17	2.13	.76	NU	1.94	.68	NU
18	2.91	1.44	NU	3.10	1.70	U
19	3.96	1.07	U	3.98	1.04	U
20	3.57	.99	U	3.48	.95	U
21	2.13	.76	NU	1.94	.68	NU
22	2.13	76	NU	1.94	.68	NU
23	2.91	1.44	NU	3.10	1.70	U
24	2.13	.76	NU	1.94	.68	NU
25	2.13	.76	NU	3.10	1.70	U
26	2.91	1.44	NU	1.94	.68	NU
27	2.78	.42	NU	1.94	.68	NU
28	2.04	.98	NU	2.74	4.43	NU
29	2.57	.84	NU	3.10	1.70	U
30	3.57	.99	U	2.48	.88	NU
31	2.13	.77	NU	3.48	.95	U
32	2.13	.76	NU	2.40	.85	NU
33	2.91	1.43	NU	3.10	1.71	NU
TOTAL	**2.85**	**0.99**		**2.48**	**1.34**	

With the average mean scores of male and female being less than 3.00, gender has no effect on teachers use of metacognitive strategies in teaching mathematics

Hypothesis 3

There is no significant difference in the mean ratings of male and female teachers' use of metacognitive strategies.

Test of this hypothesis is shown in table 7

Table 7

Mann-Whitney U Test of mean ratings of male and female teachers in the use of metacognitive strategies.

Gender	N	Mean Rank	Sum of Ranks	Mann Whitney
Male	23	37.07	852.50	573.5
Female	50	36.97	1848.50	
Total	**73**	**64.04**		

From the above 573.2 the U_A for male is smaller than 576.5 U_B for female hence was used for discussion. The result shows that there is no significant difference between male and female Mathematics teachers in the use of metacognitive strategies.

Discussion

The findings from the result indicated that among items that were regularly used by teachers were setting of goals before teaching, being aware of strategies being used, evaluating of students previous knowledge, checking students comprehension and so on, while the once sparingly used were, giving goals of each homework, thinking aloud, informing students about the strategies being used and not teaching students how to use those strategies, also use of concept mapping, journals for putting down steps they used in solving problems and summarizing of any learning activity by the students. Most of the teachers during oral discussions could not give upto three

metacognitive strategies they use. This tallies with the findings of Toit and Kotze (2009) which indicated that planning and evaluating strategies were mostly used by teachers while journal keeping and thinking aloud were least used by teachers in far away South Africa. Gender and years of teaching experience are not significant factors in mathematics teachers" use of metacognitive strategies some of these finding align with the findings of (Watt, & Maree, 2007; Leo, Teo and Chai,2010; Saemah, Yasin, Jusoff, Mohd, Amir, Mahmod Surat and Kunmin 2011.) to effectively help students to acquire metacognitive strategies teachers must model higher psychological and metacognition levels first as prerequisite to encouraging them in students.

Recommendation

Workshops, conferences and seminars should be organized by the relevant agencies such as MAN and STAN from time to time to acquit teachers on innovations in the teaching and learning of mathematics.

Conclusion

In conclusion if mathematics teachers could change from their previous ways of teaching mathematics and imbibe the use of metacognitive strategies our students' achievements generally

in mathematics will improve.

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