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EFFECT OF METACOGNITION ON SECONDARY SCHOOL STUDENTS' INTEREST IN MATHEMATICS IN GWER-EAST LOCAL GOVERNMENT AREA OF BENUE STATE

Abari, M.T & Tyovenda, T.M

Department of Mathematics Education, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

ABSTRACT

The study on effect of metacognition on secondary school students' interest in mathematics in Gwer-East Local Government Area of Benue State was an attempt to ascertain the effect of metacognitive strategy on students' interest in mathematics and to determine the effect of metacognitive strategy on male and female students' interest in mathematics. The study used a quasi-experimental design. 120 senior secondary one student (SSS1) were used. The experimental group were expose to metacognitive teaching approach while the control group were taught using the conventional method. The instrument used for data collection was Metacognitive Mathematics Interest Inventory (MMII) with a reliability coefficient of 0.83 using Cronbach's Alpha. Two hypotheses were formulated and tested at 0.05 level of significance. Analysis of Covariance (ANCOVA) was used to test the hypotheses. Results from the study revealed that the students taught mathematics using the metacognitive teaching approach showed higher interest in learning mathematics than the students in the conventional method group. The study also revealed that both the male and female students in the experimental group had interest in mathematics. The study recommended among others that; teachers should teach students how their brain is wired for growth. The beliefs that students adopt about learning and their own brain will affect their performance. Research shows that when students develop a growth mindset and a fixed mindset, they are more likely to engage in reflective thinking about how they learn and grow. Teachers should build in ways for students to "stop and take stock" during class. During class, teachers should ask students to pause for 1-2 minutes and think about what they are doing at that moment. After the pause, this could be a good time for students to ask question. By way of participation in the mathematics class, students can get interested in learning mathematics.

I. INTRODUCTION

Mathematics as a body of knowledge has contributed vastly to the development of our societies today. Mathematics is a powerful tool for global understanding and communication that organizes our lives and prevent chaos. Mathematics is the science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects. Consequently, mathematics as an intellectually stimulating subject affects every talent of human activities such as politics, economics, science and technology (Hassan, Abari, Aruwa, & Ndanusa; 2017). It deals with logical reasoning and quantitative calculation, and its development has involved an increasing degree of idealization and abstraction of its subject matter (Wilbur, 2020). The abstract nature of mathematics has dissuaded many students from studying mathematics.

Interest is the feeling of wanting to know. It entails one's level of curiosity, attentiveness, inquisitiveness, and delight to knowing something (Rodriguez, Regueiro, Pineiro, Estevez, & Valle, 2020). Making the students interested in learning mathematics can be a real challenge, although there is a lot of fluctuating that can affect their engagement. Many studies have made efforts in intervening through different approaches to promote and develop student's interest in Mathematics learning. It has become necessary for teachers to adopt strategies that would build a student's interest in learning Mathematics in the light of the persistent abysmal performance of students in mathematics which could be a reflection of apathy or loss of interest in the subject. An advanced way of involving students such that they stay engaged in their learning of mathematics is to assist them in developing greater self-regulation skills (Ajay, 2020). Student's interest in a topic carries so much ability. When the topic is linked to what the students like to do; engagement deepens as they willingly spend time thinking and creating ideas in meaningful ways. Making the learning circumstantial to real-world experience is a major learning technique with transforming for students interest (Ajay, 2020). The Interest-Driven Creator (IDC) theory suggests that students can be nurtured as creators after they have engaged in interest-driven learning activities regularly with technology support (Chan, Chen, Wong, Chang; Liao; & Ogata, 2018). Interest is a powerful motivational process that energizes learning, guides academic and career trajectories, and is essential to academic success (Harackiewicz; Smith; & Priniski, 2016). Interest is both a psychological state of attention and affect toward a particular object or topic, and an enduring predisposition to reengage over time.

Metacognition is one's ability to use prior knowledge to plan a strategy for approaching a learning task, take necessary steps to problem solve, reflect on and evaluate results, and modify one's approach as needed (Scanlon, 2016). The concept was created by John Flavell in the 1970s. It includes all the processes involved in regulating how we think. Examples include planning out our work, tracking our progress, and assessing our own knowledge. Metacognitive strategies are useful to help us study smarter (not harder) and achieve self-control. It allows us to complete a given task well through planning, monitoring, evaluating and comprehending. This means while cognitive processes allow normal functioning of individuals, metacognition takes it a level higher making a person more aware of his/her cognitive processes (Gilbert, 2016). For example, imagine a child who is completing a mathematical question; the cognitive process would allow the child to complete the task. However, the metacognitive would double check through monitoring and evaluating the answer. In the sense, metacognition helps to verify and build the confidence of the child. This is why it can be said that metacognition helps successful learning. The metacognitive strategies are the strategies that teachers often apply to help the students in understanding how they learn different skills in the learning environment. It helps the students in determining how they carry out the thinking processes (Oxford, 2013). Ideally, these processes make students aware of their own learning capabilities. Therefore, the teachers often use it in order to help the learners to become more strategic thinkers. It helps in influencing the brain processes that aid individuals in solving routine problems. It also involve scientific methods that can help in the assessment of one's thought processes. The goal of teaching metacognitive strategies in mathematics is to help learners become comfortable with these strategies so that they employ them automatically to learning tasks, focusing their attention, deriving meaning, and making adjustment if something goes wrong. They do not think about these skills while performing them but, if asked what they are doing, they can accurately describe their metacognitive processes.

There is a large body of international research on sex differences in academic interest in mathematics. Education has been considered among the basic rights of human beings. From the learning perspective, the sex has seemed to play a significant role. It plays an essential role in motivation, attitudes, and achievement of students (Mousa, 2017).

Shu and Luan (2019) carried out a study in Malaysia to examine Students' interest towards mathematics in technology-enhanced learning context. Results of the descriptive statistical analyses revealed that the students were relatively interested in mathematics. Correlational analyses showed that interest was not significantly correlated to mathematics performance among the students. Nevertheless, a significant relationship between interest and mathematics performance was found among students who had lower mathematics performance. The findings of this study pointed to the importance of igniting interest among student with lower mathematics performance given its strong link to mathematics performance.

Ghasemi & Burley (2015) investigated gender differences in interest in mathematics and found out that the meta-analysis of student like mathematics scales revealed that there was almost no gender difference in interest in mathematics between fourth graders (grand random mean ES= -0.073, grand fixed mean ES= -0.065); the effect sizes were heterogeneous [Q (47)=1596.04, $p<0.001$] and the t^2 (between nations true heterogeneity) was 0.024. the meta-analysis of gender difference in interest (i.e student like mathematics scales) for eighth graders showed that there was a slight gender difference favouring male students (Grand Mean ES= -0.106. the effect sizes were heterogeneous [Q(39) =935.85, $p<0.001$]. the t^2 value was 0.014. Regarding the unweighted effect sizes, for fourth graders, 15 countries out of 48 countries (31%), and for eighth graders 10 out of 40 countries (25%) had small to medium gender disparity in "liking mathematics". In other words, they had ds of 0.2 or more but less than 0.5 which were either positive or negative. The meta-analysis results of ten high gap and ten low gap countries are summarized in table 10. For liking mathematics construct, as mentioned previously, the overall effect size was -0.073 for fourth graders. The mean effect size for the low gap countries was -0.127 implying that boys like mathematics more than girls. However, for the high gap countries effect size was 0.071 representing girls' higher interest in mathematics. For eighth graders, the students in low gap countries revealed higher difference in interest (effect size = -0.141) compared to students in high gap countries (effect size = - 0.128), both in favour of boys.

In this regard, the main purpose of this study is to investigate the effect of metacognition on secondary school students' interest in mathematics in Gwer-east Local Government Area of Benue state. Specifically, the study seek to;

i. To determine the difference in the mean interest rating of secondary school students taught mathematics using metacognition and those taught without metacognition.
ii. To determine the difference in the mean interest rating of male and female secondary school students taught mathematics using metacognition.

Research Questions: This study provided answers to the following research questions:

i. What is the difference in the mean interest rating of secondary school students taught mathematics using metacognition and those taught without metacognition?
ii. What is the difference in the mean interest rating of male and female secondary school students taught mathematics using metacognition?

Research Hypotheses: The following hypotheses were formulated to guide the study;

i. There is no significant difference in the mean interest rating of secondary school students taught mathematics using metacognition and those taught without metacognition.
ii. There is no significant difference in the mean interest rating of male and female secondary school students taught mathematics using metacognition.

II. METHODOLOGY

The design adopted for this study was quasi-experimental design. The population for this study are all the senior secondary school one (SS1) students in the co-education secondary schools in Gwer-East Local Government Area of Benue State. The sample of students for this study was 120 students drawn from the six secondary schools.

For the purpose of this research work, Metacognition Mathematics Interest Inventory (MMII) was used. The MMII is divided into two sections (Section A and B). Section A contains the Bio-data of each respondent, while section B contains information on the research problem. A Likert-type scale of strongly agree, agree, disagree and strongly disagree was used to determine the opinion of the respondents, with regards to their feelings on the effect of the teaching style under study.

The researcher administered the pre-MMII and post-MMII to all the SS1 students in the two groups. The pre-MMII and post-MMII were administered to the selected groups at different times to avoid communication between the groups. The researcher administered the pre-MMII by visiting the studied schools, in which he had a direct contact with the respondents through hand to hand process and the pre-MMII were retrieved or collected on the same day. At the end of each teaching session the post-MMII was administered. Students noted their responses in a normal classroom situation. Data collected were analyzed using descriptive statistics of mean and standard deviation to answer the research questions while the hypotheses were tested at 5% significance level using the Analysis of Covariance (ANCOVA).

III. RESULTS

The data is presented according to research questions and hypotheses.

Question 1: What is the difference in the mean interest rating of secondary school students taught mathematics using metacognition and those taught without metacognition?

Table 1: Mean Interest Scores and Standard Deviation

Group	**Pretest**		**Posttest**		
	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Difference**
Metacognitive Approach	50.47	9.03	54.95	6.90	4.48
Conventional Approach	49.17	8.50	53.02	5.53	3.85
Total	**49.82**	**8.76**	**58.98**	**6.30**	**0.63**

Results in table 1 shows that the mean interest scores of students taught mathematics with metacognitive application method is 54.95 with standard deviation of 6.90 while that of the students taught mathematics using the conventional application method was 53.02 with a standard deviation of 5.53. The mean difference in the metacognitive application group and the conventional approach is 4.48 and 3.85 respectively. Therefore, the mean interest rating of the students taught mathematics with metacognitive teaching approach is higher than those taught mathematics with the conventional teaching method, though the difference is not much. This implies that the students taught mathematics using the metacognitive teaching approach showed higher interest in learning mathematics than the students in the conventional method group. To show if the mean interest rating in mathematics of students between the experimental and control group is significant, hypothesis 2 was tested at 0.05 level of significance.

Hypothesis 1: There is no significant difference in the mean interest rating of secondary school students taught mathematics using metacognition and those taught without metacognition.

Table 2: Summary of ANCOVA Result of Students Interest in both groups

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	1957.816[a]	2	978.908	41.375	.000
Intercept	3523.823	1	3523.823	148.940	.000
pretest	1845.683	1	1845.683	78.011	.000
group	54.130	1	54.130	2.288	.133
Error	2768.150	117	23.659		
Total	354430.000	120			
Corrected Total	4725.967	119			

a. R Squared= .414 (Adjusted R Squared= .404)

From table 2, the p-value for groups is 0.133. Hence p>0.05 the null hypothesis is accepted. This implies that there is no significant difference in the interest rating of students taught mathematics using metacognition and those taught mathematics without metacognition. It therefore means that both the students in the metacognitive method group and those in the conventional method group have interest in mathematics.

Research Question 2: What is the difference in the mean interest rating of male and female secondary school students taught mathematics using metacognition?

Table 3: Mean Interest Scores and Standard Deviation of male and female students

Sex	Pretest		Posttest		
	$\bar{x}$	SD	$\bar{x}$	SD	Mean Difference
Male	49.63	9.69	54.33	6.20	4.70
Female	51.30	8.39	55.57	7.60	4.27
Total	**50.47**	**9.03**	**54.95**	**6.90**	**0.43**

Results in Table 4 shows that the mean interest rating of the male and female students in the metacognitive teaching method group is 54.33 and 55.57 respectively. The result implies that there is no much difference between the male and female students' mean interest rating in mathematics. However, hypothesis 4 was tested to determine if the difference in the mean interest rating between male and female students is statistically significant or not.

Hypothesis 2: There is no significant difference in the mean interest rating of male and female secondary school students taught mathematics using metacognition.

Table 4: ANCOVA Result for Interest of male and female students in metacognitive approach

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	439.001[a]	2	219.500	5.275	.008
Intercept	2909.918	1	2909.918	69.931	.000
pretest	416.184	1	416.184	10.002	.003
gender	8.162	1	8.162	.196	.660
Error	2371.849	57	41.611		
Total	183981.000	60			
Corrected Total	2810.850	59			

a. R Squared= .156 (Adjusted R Squared= .127)

From table 4, the p-value for gender is 0.660. Hence p>0.05, the null hypothesis is accepted. This implies that there is no significant difference between the interest rating of male and female students in the metacognitive method group. It therefore means that both the male and female students have interest in mathematics.

IV. DISCUSSION

In table 1, the pretest result for experimental group and control group was 50.47 and 49.17 respectively. This means that students in the two groups had a similar level of interest in mathematics before the commencement of the study. However, the mean interest scores of students taught mathematics with metacognitive application method was 54.95 with a standard deviation of 6.90, while those taught mathematics with conventional approach was 53.02 with standard deviation 5.53. Therefore, the mean interest rating of the students taught mathematics with the metacognitive approach method is slightly higher than those taught mathematics with the conventional method. This implies that the students taught mathematics using the metacognitive application method showed higher interest in learning mathematics than the students in the conventional method group. Hypothesis 1 was tested to confirm that the mean interest rating in mathematics of students between the experimental and control group is significant. The result shows that the p-value for the groups is 0.133. Hence p>0.05 the null hypothesis is accepted. This implies that there is no significant difference in the mean interest rating of both groups. It therefore means that both the students in the metacognitive method group and those in the conventional method group have interest in mathematics. This finding agrees with the findings of Shu and Luan (2019) who conducted a research to examine Students' interest towards mathematics in technology-enhanced learning context and the results of the descriptive statistical analyses revealed that the students in both groups were relatively interested in mathematics.

Results in table 3 shows that the mean interest rating of the male and female students in the experimental group were 54.33 and 55.57 respectively. The result implies that there is no much difference between the male and female students' mean interest rating in mathematics. In table 8, hypothesis 4 was tested to determine if the difference in the mean interest rating between male and female students is statistically significant or not. The result shows that the p-value for groups is 0.660. Hence p>0.05, the null hypothesis is accepted. This implies that there is no significant difference between the interest rating of male and female students in the metacognitive method group. This implies that both the male and female students in the experimental group indicated a similar level of interest in mathematics. The findings of this result agree with that of Ghasemi & Burley (2015) which carried out a study to investigate gender differences in interest in mathematics and found out that there was almost no gender difference in interest in mathematics between fourth graders.

V. CONCLUSION

Mathematics is a powerful tool for global understanding and communication that organizes our lives and prevents chaos. Mathematics is a subject that should be enjoyed because of its real-life application. Many students trend Mathematics today because of its abstract nature. Getting students interested in Mathematics has been so challenging to teachers due to the fact that students come to the classroom with the mindset that mathematics is hard therefore, giving no room for interest.

Research shows that metacognitive skills can be thought to students to stimulate their interest of Mathematics. Teaching of thinking involves teaching learners about their mental processes and how these can be used for problem solving. This involves or requires teachers to intervene at the level of the mental process and teach individuals what processes to use, when, how to use them, and how to combine them into workable strategies for task solution. By applying meta-thinking strategies in Mathematics, learners can be more aware of their own control over their success at tasks. They can also adjust their thinking strategies as they go about their tasks to ensure optimum outcomes.

The above review also suggests that Teachers should teach students how their brain are wired for growth. The beliefs that students adopt about learning and their own brain will affect their performance. Research shows that when students develop a growth mindset and a fixed mindset, they are more likely to engage in reflective thinking about how they learn and grow. Teachers should build in ways for students to "stop and take stock" during class. During class, teachers should ask students to pause for 1-2 minutes and think about what they are doing at that moment. After the pause, this could be a good time for students to ask question. By way of participation in the mathematics class, students can get interested in learning mathematics.

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