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EDITORIAL

Journal of Innovations in Science Education (JISE) is a Publication of Association of Science Educators Anambra (ASEA). It is publishable both online and offline. The publication is twice a year. It embraces only on science education and innovative ideas. JIES provide an avenue for dissemination of research findings, innovative ideas and practices between researchers, science educators and policy makers in the form of original research, book review, theoretical and conceptual papers which will serve as an important reference for the advancement of teaching, learning and research in the field of science education.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Josephine N. Okoli
Editor-in-Chief

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META-COGNITIVE UTILIZATION SKILLS AS CORRELATES OF SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN ANAMBRA STATE

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Abstract

This study investigated meta-cognitive utilization skill as correlates of secondary school students' achievement in mathematics in Anambra State. Three research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The study adopted a correlation research design. A total of 18,356 SS2 students constituted the population. Proportionate stratified random sampling was employed to draw a sample size of 5,096 students from 86 out of 261 state government-owned secondary schools in the State. The instrument used for data collection was mathematics meta-cognitive utilization skill scale (MMUSS). The instrument was validated by experts in Science Education and Measurement and Evaluation. The reliability of the instrument was established using Cronbach Alpha method. The reliability coefficient of MMUSS were found to be 0.66. Method of data collection was on the spot with the aid of research assistants. Data collected were analyzed using Pearson Product Moment Correlation to answer the research questions while t-test of correlational analysis was used to test the null hypotheses. The findings of the study revealed moderate positive relationship between meta-cognitive utilization skill and achievement in mathematics and also MUS and gender. It was recommended among others that students should be encouraged by their mathematics teachers and school counsellors to construct their knowledge through planning, monitoring, regulating and evaluating their knowledge and they should take responsibility for their learning and believe in themselves and their ability.

Keywords: Meta-Cognitive, Utilization skills, Mathematics Achievement

Introduction

The word Science is derived from a latin word "Scientia" which means "knowledge". Science is a system of knowledge and a method for understanding the natural and social world through systematic observation, experimentation, and evidence-based analysis. Ogunleye as cited in Japari, Luka & Anthony (2021) defined Science as a dynamic human activities concerned with understanding the workings of our world. This understanding helps man to know more about the universe. Without the application of Science, it would have been impossible for man to explore the other planets of the Universe. Mathematics is regarded as one of the most important subjects in the school curriculum. It is the foundation of scientific and technological knowledge that contributes significantly toward the socioeconomic development of a nation. According to Enu, Agyman & Nkum (2015), Mathematics is one of the subjects that affect all aspects of human life at different level. This makes the subject a very essential to the growth of many other disciplines (Yadau, 2017). This could be the reason it is a compulsory core subject in primary and secondary schools in almost all the countries in the world. The aforementioned emphasizes the importance of Mathematics in educational system.

Adamu (2020) asserts that Mathematics influences an individual's personal development and contributes to the wealth of the country. It is one of the oldest fields of study in the history of mankind and has long been one of the most central components of human thought. The researchers also posited that Mathematics sharpens the human mind, advances rational thinking and enhances reading ability. Similarly, Adedayo (2017) posited that the knowledge of Mathematics promotes the habit of accuracy, logical, systematic and orderly arrangement of facts in the individual learner. It also encourages the habit of self-reliance and assists learners to think and solve their problems themselves.

Despite the importance of Mathematics, research evidence indicates fluctuation in students' achievement. Academic achievement which refers to a successful accomplishment or performance in a particular subject area. Academic achievement is also the extent to which a student, teacher or institution has attained their short or long-term educational goals (Okereke & Okigbo, 2019). To the researchers, academic achievement could be described as an outstanding performance in a given academic task. Mathematics achievement consists of students' performance in Mathematics examination, tests, assignment and project work irrespective of gender. Mathematics

achievement in this study would therefore be represented by scores in Mathematics taken from the students' academic records in their schools.

Gender which is a psychological construct has been used to describe maleness and femaleness. Oribhabor (2019) defined gender as a psychological and cultural term constantly developed by society to differentiate between the roles, behavior, mental and emotional attributes of males and females. Ezeh (2013) explained that gender describes the personality traits, attributes, behavior, values, relative power, influence, roles and expectations (masculinity and femininity) that society ascribes to the two sexes on a differential basis. The influence of gender on students' achievement in Mathematics has remained a controversial and tropical issue amongst educationist and psychologists.

Ajai and Imoko (2015) assessed gender differences in Mathematics achievement and retention by using problem-based learning (PBL). The study revealed that male and female students taught algebra using PBL did not significantly differ in achievement and retention scores. Ghazvini and Khajehpour (2011) examined gender differences existing in various cognitive motivational variables (locus of control, academic self-concept and use of learning strategies) and performance attained in school subjects of literature and Mathematics. The study revealed the existence of gender difference in variables under consideration, with girls getting better marks in literature and boys getting better marks in Mathematics. Kwame, McCarthy, McCarthy and Gyan (2015) investigated the differences in elective Mathematics achievements of final year senior secondary school students and found girls in mixed-sex schools achieving higher than their male counterparts. Omenka and Kurumeh (2013) sought to establish relationship between achievement and gender, using ethno Mathematics approach. The findings of the study showed that there is no significant effect of gender on students' achievement in number and numeration when taught using ethno Mathematics approach. Based on the above studies, gender have not been stable on Mathematics achievement, hence the need for continuous verification.

Studies have been carried out on ways of improving the level of mathematics achievement in Nigerian secondary schools irrespective of gender (Esiana, 2012; Odili, 2006; Okigbo & Okeke 2017). Most of these studies are on student - based, teacher-based and society-based factors without addressing how the students themselves think about solving Mathematics. One of such student-related factor is students' meta-cognitive and self-regulatory skill. Meta-cognition has great potential in increasing the meaningfulness of students' classroom learning. The concept of meta-cognition is

related to the knowledge of "when" and "how" to use particular strategies/skills for learning or problem solving (Jaafar & Ayub, 2010). Meta-cognition means "thinking about thinking" or "second-level cognition" It is the ability of self-reflection of the ongoing cognitive process; it is something that is unique to the individual which plays an important role in human consciousness. Meta-cognition shows a person's thinking (SetyaMurti, 2011). It is also concerned with knowing how to reflect, how to draw conclusions on the practice. In other words, meta-cognition is also concerned with how the performance has a significant effect on cognitive tasks such as remembering, learning and problem solving (Dowing, 2009).

Meta-cognition includes knowledge of general cognitive strategies, knowledge of monitoring, evaluation and regulatory strategy. Meanwhile, meta-cognitive strategy/skills refer to methods used to help students understand the way they learn. By using meta-cognitive strategy, students can develop appropriate plans during the teaching and learning process either by memorizing or as eventually a routine which they use in studying. Most students learn how to monitor and regulate steps and procedures used to meet the goal of solving problems (Ozsoy, 2010). Mathematics meta-cognition therefore refers to knowledge about "when and how" to use particular skills for learning and problem solving in Mathematics (Rezuan, Ahmadi & Abedi, 2006). According to Zimmerman (2001), learners need to engage in a variety of cognitive processes to monitor and control their learning. These basic meta-cognitive processes of monitoring and controlling which learners engage in are; assessing the task at hand, evaluating their knowledge and skills, planning their approach in a way that accounts for current situation, applying various strategies to enact their plan, monitoring their progress along the way and monitoring their progress and adjusting their strategies as needed. These five key meta-cognitive processes also called meta-cognitive skills are critical to one becoming an effective self-directed learner, self-regulated and lifelong learner.

In the context of students' learning of Mathematics, the meta-cognitive skills that are required include things like; students' having the ability to understand exactly the Mathematical task given, being able to evaluate their abilities realistically in specific mathematics topics so as to engage in appropriate strategies that will lead to good learning outcomes, being able to plan an appropriate approach to the Mathematics task at hand, being able to monitor their performance as they apply their chosen strategies that implement their plans and being able to reflect and adjust their approach as needs arise. Research findings such as Eze (2007) suggest that students tend not to utilize

meta-cognitive skills more often as they should and this no doubt has negative consequences in their achievements in school subjects in general and Mathematics in particular. This could have resulted to students' poor academic achievement in Mathematics over the years despite all the research findings on the best ways to improve achievement in the subject through the use of effective teaching methods.

Statement of the Problem

Despite the highly decorated and recognized importance of Mathematics and the fact that it is the prerequisite for most of the subjects, dwindling achievement and lack of interest in Mathematics among students remains as an issue of concern in colleges and universities in developing countries. The academic achievement of secondary school students in Mathematics is a very important issue as it has significant impact on their future career choices.

Over the years, many researchers have focused their research studies on discovering the factors and ways of minimizing the high rate and dwindling achievement of students in Mathematics both in internal and external examinations. Many efforts had been made in the past to improve the effects of these factors, yet available data and research indicate that performance still fluctuates. From the available literature to the researchers influence of students' Mathematics meta-cognitive utilization skills on their academic achievement in Mathematics has not been given adequate research attention in Nigeria. The problem of this study is to determine the students' Mathematics meta-cognitive utilization skills on their academic achievement in Mathematics.

Purpose of the Study

The purpose of the study was to determine meta-cognitive utilization skills as correlates of secondary school students' academic achievement in Mathematics in Anambra state. Specifically, the study determined;

1. Relationship between students' meta-cognitive utilization skills (MUS) scores and academic achievement scores in mathematics.
2. Relationship between male students' MUS scores and academic achievement scores in mathematics.
3. Relationship between female students' MUS scores and academic achievement scores in mathematics.

Research Questions

The following research questions guided the study;

1. What is the relationship between students' metacognitive utilization skills (MUS) scores and academic achievement scores in mathematics?
2. What is the relationship between male students' MUS scores and academic achievement scores in mathematics?
3. What is the relationship between female students' MUS scores and academic achievement scores in mathematics

Hypotheses

The study tested the following null hypotheses at 0.05 level of significance;

1. There is no significant relationship between MUS scores and students' academic achievement scores in mathematics.
2. There is no significant relationship between male students' MUS scores and academic achievement scores in mathematics.
3. There is no significant relationship between female students' MUS scores and academic achievement scores in mathematics.

Methodology

The correlation research design was adopted for the study. The correlation research design, according to Nworgu (2015) is used to establish a relationship between two or more variables. The study was carried out in Anambra State, Nigeria. The population comprises 18,356 Senior School (SS2) students in the 261 state government-owned secondary schools within Anambra State made up of 8,226 males and 10,130 females. The sample comprises 5,590 SS2 students drawn from 86 out of 261 state government-owned secondary schools in Anambra state. The study utilized multistage sampling technique in which the sample was selected.

Firstly, the population is already in strata based on the six education zones; Aguata, Awka, Nnewi, Ogidi, Onitsha and Otuocha respectively. Secondly, the researchers used a proportionate sampling hence one-third of government-owned schools in each stratum gave Aguata 16, Awka 20, Nnewi 17, Ogidi 13, Onitsha 11 and Otuocha 9. This was done in order for each zone to have a proportionate representation. Also, it is worthy to note that each of the Education zones are made up of local government areas. Some of these local government areas are urban while some are rural. Hence, proportionate sampling was used again to select schools from each local government area to give a true representation of both urban and rural schools.

The researchers also adopted purposive sampling in selecting schools that are mainly co-educational while in some local government areas that have single-sex schools it was selected randomly to have equal number of schools. This took care of the moderating variable gender. Finally, 65 students were selected by means of simple random sampling though some schools have more population than others, so the researchers distributed more to schools with such population this was based on the fact that some schools do not have large population and to make up the total sample.

Mathematics Meta-cognitive Utilization Skill Scale (MMUSS) was the instrument used for data collection. The MMUSS was pulled piecemeal from literature. This was because the researchers were unable to get an instrument suitable for the research work before the commencement of the research. The instrument consists of 18 items with five (5) clusters namely; assessing tasks at hand, evaluating ones strength and weakness, planning appropriate approach, monitoring progress and able to reflect and adjust. Also, students' achievement scores in mathematics were obtained from their respective schools. MMUSS was submitted to three experts, one expert each from Science Education, Measurement and Evaluation and Educational psychology all from NnamdiAzikiwe University, Awka for validation. The reliability of the instrument was established by administering the questionnaire once to 20 SS2 students randomly selected from Community Secondary School, Ugwoba in Enugu State which was outside the area of the study. The scores obtained were computed using Cronbach alpha and these yielded internal consistency value of 0.66 which is found reliable. The questionnaire at the end of administration and filling were collected on-the-spot. The students' termly results were collected from the subject teachers and form teachers. This was done after the students have responded to the instruments and their numbers on the class register were used to obtain the scores. At the point of collation of data, 494 of the filled instrument were not properly filled so they were discarded. The total collated sample summed up to 5,096 (91.2%). In analyzing data collected, Pearson Product Moment Correlation was used to answer research questions and t-test of correlational analysis was used to test the significant relationship in hypotheses.

Results

Research Question 1: What is the relationship between students' meta-cognitive utilization skills (MUS) scores and academic achievement scores in Mathematics?

Table 1: Pearson r on Students' Meta-cognitive Utilization Skills (MUS) Scores and Academic Achievement Scores in Mathematics

Source of variance	N	MUS (r)	Mathematics (r)	Remark
MUS	5096	1.00	0.68	
				moderate positive relationship
Mathematics achievement	5096	0.68	1.00	

In Table 1, it was observed that a moderate positive relationship (r = 0.68) existed between students' meta-cognitive utilization skills (MUS) scores and their achievement scores in mathematics.

Research Question 2: What is the relationship between male students' MUS scores and academic achievement scores in Mathematics?

Table 2: Pearson r on Male Students' Meta-cognitive Utilization Skills (MUS) Scores and Academic Achievement Scores in Mathematics

Source of variance	N	MUS (r)	Mathematics (r)	Remark
Male MUS	2241	1.00	0.71	
				Strong positive relationship
Mathematics achievement	2241	0.71	1.00	

In Table 2, it was observed that a strong positive relationship (r = 0.71) existed between male students' meta-cognitive utilization skills (MUS) scores and their achievement scores in Mathematics.

Research Question 3: What is the relationship between female students' MUS scores and academic achievement scores in Mathematics?

Table 3: Pearson r on Female Students' Meta-cognitive Utilization Skills (MUS) Scores and Academic Achievement Scores in Mathematics

Source of variance	N	MUS (r)	Mathematics (r)	Remark
Female MUS	2855	1.00	0.55	Moderate positive relationship
Mathematics achievement	2855	0.55	1.00	

In Table 3, it was observed that a moderate positive relationship (r = 0.55) existed between female students' meta-cognitive utilization skills (MUS) scores and their achievement scores in Mathematics.

Hypothesis 1: There is no significant relationship between meta-cognitive utilization skills (MUS) scores and students' academic achievement scores in Mathematics.

Table 4: t-Test of Significant Relationship between Students' Meta-Cognitive Utilization Skills (MUS) Scores and their Achievement Scores in Mathematics

Correlation coefficient (r)	N	Df	t-cal.	p-value	A	Decision
.68	5096	5094	0.718	0.474	0.05	Not Sig

Table 4 indicates that at 0.05 level of significance and 5094 df, the calculated t 0.718 with p-value 0.474 which is greater than 0.05, the null hypothesis is not rejected. This implies that there is no significant relationship between students' Mathematics meta-cognitive scores and their achievement scores in Mathematics.

Hypothesis 2: There is no significant relationship between male students' MUS scores and academic achievement scores in Mathematics.

Table 5: t-Test of Significant Relationship between Male Students' MUS Scores and their Achievement Scores in Mathematics

Correlation coefficient (r)	N	Df	t-cal.	p-value	α	Decision
.71	2241	2239	0.908	.366	0.05	Not sig

Table 5 indicates that at 0.05 level of significance and 2239 df, the calculated t 0.908 with p-value 0.366 which is greater than 0.05, the null hypothesis is not rejected. Therefore, it means that there is no significant relationship between male students' Mathematics MUS scores and their achievement scores in Mathematics.

Hypothesis 3: There is no significant relationship between female students' MUS scores and academic achievement scores in Mathematics?

Table 6: t-Test of Significant Relationship between Female Students' MUS Scores and their Achievement Scores in Mathematics

Correlation coefficient (r)	N	Df	t-cal.	p-value	α	Decision
.71	2855	2853	7.89	.000	0.05	Sig

Table 6 indicates that at 0.05 level of significance and 2853 df, the calculated t 7.89 with p-value 0.00 which is less than 0.05, the null hypothesis is rejected. Therefore, it means that there is significant relationship between female students' Mathematics MUS scores and their achievement scores in Mathematics.

Discussion

The finding of the study revealed that there is a moderate positive relationship between students' meta-cognitive utilization skills and their achievement in mathematics. This moderate positive relationship is in line with the findings of Zulkiply (2012) and Rani and Govil (2013) whose study reported positive relationship between students' meta-cognition and their academic achievement prompting them to recommend the awareness of meta-cognitive skills. The researcher is of the view that the reason why there is a moderate relationship between students' meta-cognitive utilization skills and achievement could be that meta-cognitive skills are usually conceptualized as an interrelated set of competencies for learning and thinking and also include many of the

skills required for active learning such as critical thinking, reflective judgment, problem solving and decision-making which might enhance one's achievement.

However, on testing the null hypothesis in table 4, the study revealed that there is no significant relationship between students' mathematics meta-cognitive scores and their achievement in mathematics.

The finding of this study agreed with the findings of Smith (2013) who found that students' performance as measured by course grade, could not be predicted by meta-cognitive awareness levels. The researcher is of the opinion that when students' fail to plan ahead, choose the right strategy every time to solve a particular task, monitor, evaluate, reflect and adjust their skills in learning mathematics which could reflect in their mathematics achievement.

The finding of this study from Table 2 also revealed that a strong positive relationship existed between male students' meta-cognitive utilization skills and their achievement in mathematics. However, table 4 indicates that there is no significant relationship between male students' mathematics meta-cognitive utilization skill scores and their achievement scores in mathematics. The finding on Table 3 indicates moderate positive relationship exists between female students' mathematics meta-cognitive utilization skill and achievement in mathematics. This relationship was confirmed in table 6 which showed that there is significant relationship between female students' mathematics meta-cognitive utilization skill scores and their achievement in mathematics.

Leister (2016) found significant difference in favor of female participants which agrees with the finding of the study which is in favor female students while Zulkiply (2012) found significant positive relationship between students' academic performance and meta-cognitive awareness but revealed that gender did not affect meta-cognition awareness which is contrary to the finding of the study which showed significant relationship existing between female students' mathematics meta-cognitive utilization skill scores and their achievement in mathematics. Also, the finding of Rani and Govil (2013) disagrees with the finding of the study in that it was found that gender has no significant impact on the meta-cognition of undergraduate students.

Conclusion

The study concludes that there is moderate positive relationship between students' meta-cognitive utilization skills (MUS) scores and their achievement scores in Mathematics. Also, there is a strong positive relationship between male students' meta-

cognitive utilization skills (MUS) scores and their achievement scores in Mathematics and a moderate positive relationship was found to exist between female students' meta-cognitive utilization skills (MUS) scores and their achievement scores in Mathematics. In light of this, one can say that meta-cognitive utilization skills are important indicator of mathematics academic achievement. This means that when one is able to develop a more convenient approach to solving Mathematics, even in the face of difficult concepts, he/she will achieve better.

Recommendations

It was recommended that;

1. Mathematics teachers should make effort to equip themselves by attending workshops, seminars and conferences; this is to acquaint themselves with appropriate strategies/skills of teaching/instruction like meta-cognitive skills. This will go a long way in reducing the tension of students' during the mathematics class because the students are aware that their activities are being monitored by their teacher.

2. Students should be encouraged to learn and utilize their meta-cognitive skills and be more aware of their own thinking/how they learn best. Mathematics teachers should make effort to make use of skills like questioning to trigger meta-cognitive utilization in their students.

3. Government should provide incentives that will attract teachers to the rural areas. Also equal supervisory activities by ministry official should get to all schools irrespective of location.

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