The Impact of Metacognitive Teaching Strategies on Learners' Performance in Earth Geometry: A Case Study of Mubanga Secondary School

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Abstract*—Mathematics is one of the useful subjects that is often applied by people in society. The knowledge and skills obtained from learning mathematics are used by several people to solve their everyday problems. Not only that, other subjects are depending on mathematics in that they need some elements of mathematics for them to be learnt properly. A good example of such subjects includes science, economics, accounts, woodwork and technical drawing. The unfortunate part is that the subject of mathematics has been proven to be difficult among most of the learners to an extent that most of them (learners) perform poorly in it. The poor performance of learners in mathematics has been a source of concern to many stakeholders. This research study was conducted to assess the impact of metacognitive teaching strategies on learners' performance in Earth Geometry since the traditional method of teaching (lecture method) seem not to helps learners to attain academic achievement in Earth Geometry and mathematics in general. A sample of 94 participants, 45 boys and 49 girls were purposively sampled from Mubanga Secondary School. The participants were actually members of the only two grade twelve classes, 12A and 12B, that were at Mubanga Secondary School at that time .The treatment was randomly assigned and 12A was considered to be the experimental group while the other class, 12B became the Control group. Using a quasi-experimental research method, the experimental group experienced 16 training sessions of Metacognitive teaching strategies while the Control group was deprived of the training. Pre-test and post-test were used as suitable instruments to collect the much needed data. The instruments were tested for reliability and validity. Reliability of research instrument was tested using test retest reliability and Pearson's product moment correlation coefficient gave the value of r = 0.748. This result showed that there was a strong linear relationship between the two tests that were conducted for assessing reliability. Validity of instruments was done using face and content validity. Two grade twelve examiners were given chance to look at the test instruments. The independent sample t-test was used to analyse the results to determine the impact of metacognitive teaching strategies towards learners' performance in Earth Geometry. The results showed that the experimental group had statistically significant mean scores of the post-test results compared to the mean scores of the Control group for the same post-test. Based on the results of the research study, it was concluded that metacognitive teaching strategies had a positive impact on learners' performance in Earth Geometry

***Keywords*— metacognition, metacognitive strategies, cognition, strategy.**

I. INTRODUCTION

The demands of society have the greatest influence to the kind of education system that should be given to every society. In the same vain Bruner (1996), says culture or society has the influence to manage its system of education for education is a major embodiment of a culture's way of life and not just a preparation for it. This is so because out of the education system, society attains the much needed knowledge, skills and values that are cherished by the members of that society for them to survive well; members of the community should be able to solve their problems. The mode of transmission of knowledge, skills and values greatly affects how the teaching and learning of pupils should be conducted. In the 21st century, there is so much innovations and technology that have brought many things on board which require lifelong learning and the challenge of people to find solutions to their numerous problems. These innovations, technological knowhow and skills needed to address numerous problems in society have caused a change in the system of education more especially on how learners should learn and be taught. To this effect,

The current education system has shifted its focus from knowledge transmission to knowledge construction, aiming to achieve self- regulated and lifelong learning. Central to self-regulated learning is the concept of metacognition. (Conford, 2012) in (Backer, 2011). (Izadi, 2018), the concept of metacognition actually means the awareness of one's learning process or how to learn. (Tayeh, 2018) other scholars describe metacognition as the process of consciously monitoring our own thought process and a process is a form of looking over your own shoulders- observing yourself as you work and think about what you are thinking. Metacognition plays an important role in education because it helps learners to be capable of developing a plan, monitor and evaluate how much it is effective, that means metacognition helps the learners to be more involved in the learning process(Abdellah, 2015). Lifelong learning is needed because of numerous technology that has brought many things and for society members to copy up with the changing world, they need to learn how to learn.. Self-regulated learning according to (Hester, 2018), is an active constructive process whereby learners set goals for

their learning and attempts to monitor, regulate and control their cognition, motivation and behavior guided and constrained by their goals and the contextual features in the environment." In this way learners are said to be in control of their own learning.

To address such a challenge(Montague, 2018), states that self-regulation strategies such as self-instruction, self-questioning, self-monitoring, self-evaluation and self-reinforcement, help learners to gain access to cognitive process that facilitate learning, guide learners as they apply the process within and across domains and are regulated for their application and overall performance of a task.

If learners are capable of making plans of what they intend to do, monitor and evaluate their plans, it means they understand their own learning and because of that they can possibly manage to take full responsibility of their own learning and such learners would have learnt how to learn. This is actually in response to the challenges of preparing careers in the 21st Century, students are required to be more and more in control of their own work (Hester, 2018). (Abdellah, 2015) emphasized the need to prepare students for a society which rapidly develops and in which continuous new knowledge and skills are required. It was quiet clear from research evidence that the quality of teachers' knowledge or beliefs, intentions and plans with respect to how people learn influences teachers' teaching actions and that those teaching actions could directly influence students' learning outcomes and in addition to that, the quality of students' knowledge about how they learn influences their engagement with learning and consequently their learning achievements (Williams, 2012). From this information it becomes obvious that the educators' knowledge and methodology have a great bearing to determine the level at which learners achieve the learning outcome in their learning experiences

II. TEACHING AND LEARNING

2.1 Teaching and Learning

Teaching and learning are continuous and lifelong exercises which should not be limited to which is learn in classroom setting but should go far beyond that level. This is so because long after school, we find ourselves in experiences that subject us to either learning or teaching and the trend would continue as long as a person is alive. It becomes imperative for educators to avail the required knowledge and skills necessary to the learners when they are still in school so as to equip them to do in society. Mathematics is one of the subjects that is taught in schools.

(Babakhani, 2011), Mathematics learning is now viewed from a social cultural perspectives on which the content for learning and the relationship between social interacts and cognitive developments are considered important factors.

Learning mathematics is characterized with problem solving and successful problem solving is dependent upon the interaction and influence of cognitive and metacognition.

2.2 What is Metacognition

(Tayeh, 2018) metacognition is the process of consciously monitoring and regulating our own thought processes. A process in this context is a form of looking over your own shoulders by observing yourself as you work and thinking about what you are thinking. It actually deals with knowledge and awareness of one's cognitive strengths and weakness as well as self- regulation which guides an individual in engaging in cognitive activities (Warges, 2011). For example, a person is engaging him or herself in metacognition if he or she notices that he or she is having more trouble learning A and B; if it strokes that person that he or she should double check C before accepting it as a fact; she should scrutinise each and every alternative in a multiple –choice task before deciding which is the best one (Schoented, 1992).

2.3 Components of Metacognition

Metacognitive knowledge and metacognitive regulation are the two components that form up metacognition (Backer, 2011).

Metacognitive knowledge refers to learners' knowledge about their personal strengths and weakness, pertaining to a specific task and this may vary between tasks, strategies, goals and other things relevant towards achievement of a pursuit goal information (Mpiontini, 2017). Metacognitive knowledge is further subdivided into thr4ee subcomponents which are declarative, procedural and conditional knowledge (Ajisuksmo, 2017).

Declarative knowledge is concerned with the knowledge about oneself as a learner and the factors that influence his or her learning performance and it even includes their affective state as well as self- efficacy, motivation and how much these affect task performance (Mpiontini, 2017), Shannon (2008) when learners try to develop a sense of their own knowledge, they can be advised to ask themselves questions such as, "what do I know? "What don't know? And what do, need to know?" These types of refractive customs can help students to become more self – aware and help themselves to make real world connections to the information they are currently learning.

The other aspect of declarative knowledge which is so critical in the learning process is motivation. Students with metacognitive skills facilitate their learning process in mathematics lesson by applying the strategy of supervision and control which further influences their intrusive motivation (Izadi, 2018) intrinsically motivated learners will see very few goals as unattainable because such learners have a strong believe that anything is possible with much effort (Shannon, 2008).

Besides that, an intrinsically motivated learners undertakes an activity for its own sake, for the enjoyment it provides, the learning it permits, or the feeling of accomplishment it evolves (Shannon, 2008). Contrary to that, an extrinsically motivated learner performs in order to obtain some reward or

avoid some punishment external to the activity itself such as grades, or teacher approval (Shannon, 2008).

It can therefore, be concluded that metacognition affects a learner's motivation to learn because it affects attribution and self- efficacy. Self –efficacy is defined as people's beliefs about their capabilities to do something up to the required standard level of performance (Shannon, 2008). A person with strong feeling of efficacy strongly influences person's achievement level and personal comfort in many ways (Shannon, 2008). When considering achievement with regard to motivation, it is also important to reflect on a person's attributes. A person tends to attribute the results of an activity to either extrinsive factors or internal factors. Based on some positive influence of self- efficacy and motivation towards educational achievement, learners with strong sense of efficacy will tend to attribute their results from internal factors such as effort, motivation and abilities rather than on external factors as chance and luck. Marriajose (2012) disclosed the beauty of self- efficacy and motivation which are both influenced by metacognition by say that motivated students take advantage of the opportunities they have to optimise of the opportunities they have to optimise their learning and are likely to persist and to find effective way of dealing with harder tasks.

Procedural knowledge refers to one's knowledge about learning strategies and execution of procedural skills (Mpiontini, 2017), procedural knowledge would enable a learner to select an appropriate strategy for a given task. Questions such as what strategy should use with regard to the task? And what steps should I do so that I can complete a given learning task are quite important. For instance, if a person knows that using the quadratic formula can help him or her to solve a problem such as x^2 -2x + 1, knowing that when term stack on a problem it sometimes help me to first solve, simpler versions of the problem and knowing that taking my time working slowly and checking my steps lead to more correct answers means that such a person is using procedural, knowledge as he or she works on a given task (Garofao, 1986).

Conditional knowledge deals with a person's knowledge about when, where and why should someone decide to use a certain cognitive action or strategies (Mpiontini, 2017). Conditional knowledge helps learners to select different strategies most appropriate for each situation is an effort to better regulate their learning (Mushman, 1995).

2.4 Regulation of Cognition

The regulation aspect of metacognitive knowledge involves, decisions one makes concerning when, why and how one should actually explore a problem, plan course of action, monitor one's action and eventually evaluate one's progr4ess plans, actions and results (Philip Wong, 1989). Regulation of cognition is controlled by one's cognitive knowledge. For example, if a student believes that he or she makes many computation mistakes when solving mathematical problems, then such a student has to be very careful whenever there are computation operations to perform and should attempt to monitor the operations carefully to check and to evaluate the answer obtained to each and every question.

Metacognitive regulation is subdivided into three major subcomponent of planning, monitoring and evaluation.

1) (Mpiontini, 2017) planning should be undertaken before a person gets involved into a task set before him or her and this should be done regardless of the context in which the task is exposed to the right candidate and also regardless of the content of the task.
2) Plans are made to achieve the self goals.
3) Monitoring of cognition is concerned with the awareness of comprehension and self- assessment during a learning situation (Mpiontin, 2017), monitoring promotes appropriate use of specific strategies and encourages the successful problem solving process (Majorie Montague, 2008).
4) Evaluation involves learners' judging their own activities upon completion of a learning cycle (Backer, 2011). Evaluation is based on the results achieved and the defection of the learner's reactions to the results. When learners evaluate their learning, they may ask themselves if they were to perform a certain learning activity again they may act differently (Mpiontin, 2017).

2.5 Cognitive and Metacognitive Strategies

A strategy is simply a means or way by which a learning goal can be achieved and it is applied intentionally and purposefully with an idea of achieving a goal (Hester, 2018). There are quite a number of strategies which can be used to solve different tasks at different times. Some of these strategies include cognitive and metacognitive strategies.

Cognitive strategies are strategies that are very much helpful in the understanding and remembering of particular information and they make learning materials to be more meaningful by learners. The components of cognitive strategies includes rehearsal, elaboration and organizational strategies (Hester, 2018).

a) Rehearsal strategy is based on review repetition or recitation techniques to facilitate the process of attention, coding and retention of information at superficial memory level (Maria Jose, 2012). Through this strategy, it is believed that repeating and re-reading the material to be learnt, a learner is aided to remember the content of the material at hand and be able to use it.
b) Elaboration strategy allows different build relationships between different learning points and it establishes relationships in the learning content, facilitating commitment to long- term memory (Maria Jose, 2012). Elaboration would help learners

to build connections between new material and what is known already.

c) Organisational strategies are used by learners in the process of categorising and structuring of information to be learnt (Hester, 2018).

Metacognitive strategies are methods that are used to help learners to understand. They way they learn through the process of managing, monitoring and evaluating their learning and think about their thinking (Pandya, 2015). Because metacognitive strategies involve aspects of control, monitoring and reflection of one's own thinking, they are regarded to be higher-order skills which are more difficult to teach than cognitive strategies (Hester, 2018). The following are some of the metacognitive strategies: (a) planning strategy.

Planning involves the working out of how a task might be approached before it is done (special education support service, 2009). Planning requires someone to spend a bit of time to critically analyse the task at hand and come up with a workable means on how to tackle the task.

b) Monitoring Strategy

monitoring strategy is a process of checking if somebody is still on the right track of what is being done and be done to make some adjustments where possible (Hester, 2018). Monitoring can be done through self-asking the questions like "Why are we doing this work?" How can I do that?" What can I do in some way else?" The beauty about monitoring apart from it being attained by training and practice, is that it can lead to students or learners to improve in their educational performance creativity and accuracy (Mitra, 2011).

c) Thinking aloud strategy

Thinking aloud as a strategy in which a person expressly his or her thoughts while reading a text or doing a learning assignment (Mitra, 2011). Teachers should promote the habit of thinking aloud when learners solve problems and this would help learners to develop their thinking skills (Toit & Kotze, 2009).

d) Generating Questions Strategy

(Toit & Kotze, 2008), the strategy requires learners to ask themselves questions concerning what they know and what they don't know at the beginning of a learning activities.

e) Learners should ask themselves questions before, during and after the learning process. The only difference is that the set of questions they should ask themselves should differ depending on the stage at which they are in the learning process. Such questions would help learners to link their prior knowledge to the new learning material and when they get to a point where they do not understand, they should give a pause and make a focus on that question.

f) Cooperative learning strategy

Cooperative learning strategy creates the opportunity for learners to work in small groups to enhance learning (Toit & Kotze, 2009). Individual learners differ from each other as their ability to comprehend, organise and use necessary information and these differences are associated with metacognition (Mandaci, 2013). But when learners work together in small groups, they get an opportunity to easily share their ideas on a task at hand, hence scaffolding one another during the learning process.

III. METHODOLOGY

The research study employed a mixed type of research and a gauss-experimental pre-test post-test control group research design The instruments used to collect data were the pre-test and post test. These instruments were tested for reliability and validity before they were put into use. To test for reliability a test –retest reliability was used. Validity was tested using face and content validity. Data collection procedure was started by administering a pre-test at the same time to the control and experimental group. This was conducted to assess whether both groups had the same proficiency in the topic of earth geometry before the treatment was introduced to the experimental group. The pre-test way followed by the actual teaching of the experimental and control group by the same researcher. During the lessons, the experimental group was taught using metacognitive strategies (treatment) while the control group was taught using the traditional method of teaching (lecture method). At the end of the learning activities, both groups were subjected to write the post- test. The results of the post-test were useful to determine the impact of metacogintive strategies on learners performance in earth geometry.

The results of the study were analyzed using the t-test statistical test which included the independent sample t-test and paired sample t-test. The independent sample T-test was used to analyse results of the independent groups such as control and experimental group. The paired sample t-test was used to analyse results of dependent groups. For instance pre-test and post –test results of experimental group only. Before the collected data was analyzed, a test of normality of distribution was conducted using a histogram and PP plot. A box plot was used in the process to check for outliers. The results of the normality test for distribution were approximately normal and that indicated that t-test was suitable to analyse the data.

IV. RESULTS

This section presents results of the research study on the impact of metacognitive teaching strategies on learners performance in earth geometry: A case study of Mubanga Secondary School.

To start with, table 1 illustrates experimental and control group in the pre-test scores in earth geometry.

Table 1: Summary statistics in the comparison between the experimental and control group in the pre-test scores in earth geometry

GROUP	N	Mean	SD	DF	T	Sig
EXPERIMENTAL GROUP	50	9.200	5.18632			
				92	-0.208	0.836
CONTROL GROUP	44	9.4318	5.6255			

The results in table 1 above showed that the researcher failed to select the null hypothesis at t= -0.208, df = 92 and p-value = 0.836 because the p-value was bigger than the level of significant of 0.05. When the null hypothesis is not rejected, it means that there was no significant different between the means of the two groups being compared. In this case the experimental and control group had the same proficiency on the topic of earth geometry in the pro-test.

Table 2: Summary statistics on the comparison between pre-test and post-test scores of the experimental group in earth geometry

GROUP Experimental	N	Mean	SD	DF	T	Sig
Pre-test	50	9.300	5.0577			
				49	-19.962	0.000
Post –test	50	57.800	16.00893			

Table 2: above shows that the research rejected the null hypothesis t = -19.962, df=49 and p-value 0.000 the p-value is smaller or less than the level of significant. This simply meant that there was statistically significant difference between the pre-test and post-test results of the experimental group. The difference could have been attributed to the use of met cognitive strategies.

Table 3: summary statistics on the comparison between pre-test and post – test scores of the control group its earth geometry.

GROUP Experimental	N	Mean	SD	DF	T	Sig
Pre-test	44	9.3009.3182	5.66414			
				43	-21.337	0.000
Post –test	44	50.9091	12.54169			

Table 3 above shows that the p-value of 0.00 was less than 0.05 level of SIGNIFICANCE. This prompted the research to reject the null hypothesis at t= -21.337, df = 43 and p-value = 0.000. for the null hypothesis to be rejected, it meant that there was statistically significant difference between the pre-test scores and the post-test mean score of the control group.

Table 4: summary statistics on the comparison between experiment and control going in their mean score of the post-test is earth geometry.

GROUP	N	Mean	SD	DF	T	Sig
Experimental		57.800	16.0089			
Group	50			92	2.300	0.024
Control	44	50.9091	12.54569			
Group						

Table 4 above shows that the p-value of 0.024 was less than the level of significance of 0.05 and this made the researcher to reject the null hypothesis at t = 2.300, df = 92 and p-value = 0.024. This meant that there was statistically significant difference between the mean scores of the experimental and control group in the post-test results. In other words the difference in performance between the experimental and the control group was not by chance, but it had overwhelming evidence. The mean scores further reveal that the experimental group had better results than the control group.

The difference in performance between the control and experimental group was attributed to metacognitive strategies.

V. DISCUSSION OF FINDINGS

The first research question aimed to find differences in performance level on the topic of earth. Geometry between learners in the experimental and control group before an intervention was given to the experimental group. The findings revealed that the researcher failed to reject the mull hypothesis at t = -0.208, df = 92 and p- value = 0.836. Since the p- value of 0.836 was bigger than the level of significant of 0.05, it meant that there was no statistically significant difference in terms of performance level between learners in the experimental and control group; the two groups had the same knowledge level on the topic of earth geometry before an intervention was subjected to the experimental group. The findings were in conformity with the literature that stated that caring out mathematical activity requires a kind of knowledge and skills (Garofalo, 1986).Both learners performed poorly in the pre – test because they did not have enough knowledge on earth Geometry. It was also found that the use of metacognitive strategies was less common in comparison to traditional teaching approaches (Arther, 2013).

The second research question was focused on finding differences in performance between pre – test and post test of each group. The findings showed that both group had the p – value of 0.000 which was less than the level of significant of 0.05. This indicated that both groups had experienced statistically significant difference between pre – test and post test. The improvement of performance was as a result of the methods of teaching which were used for each group.

The third research question sought to find out whether metacognitive strategies had an impact on learners' performance in earth geometry. The findings showed that at t = 2.3, df = 92 and p – value = 0.024, the researcher rejected the null hypothesis. This indicated that there was statistically significance difference between the performance of learners in the control and experimental group in the post – test. The control group had a mean score of 50.9091 in the post – test against a mean score of 57.800 for the experimental group. The results indicated that the experimental group which was taught using metacognitive strategy outperformed the control group that was taught using the traditional method of teaching. These results were consistent with other authors. For instance Darren N (2017) studied on metacognitive strategies: their effects on students' academic achievement in mathematics and engagement in mathematics. The results were that the academic achievement of grade 9 students when taught using metacognitive strategy was very satisfactory while the students with the control group was fairly satisfactory. In another study, Mandaci and Kandir (2013) studied the effect of using metacognitive strategies for solving problems on students achievements and attitudes. The results were that the experimental group which used the metacognitive strategies had significantly higher post – test scores compared to the control group.

VI. CONCLUSION

The purpose of the research study was to find out whether, metacognitive teaching strategies had an impact on learners' performance in earth geometry. Based on the results, the conclusion of the study was consistent with Galyo and Dales (2017) that metacognitive strategies are effective is improving students academic achievement as compared to the traditional method teaching.

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