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Impact Of Working Memory On Students' Learning Achievements In Mathematics At Secondary Level

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Abstract

This study was designed to find out the impact of working memory on students' learning achievements in mathematics at secondary level. Sample of the study comprised 120 students studying mathematics in grade 9. Digit backward test was employed to calculate the working memory capacity of the students while learning achievement test was designed by the researcher in consultation with the subject specialists in mathematics. Post Hoc Test was utilized to analyze data and to find out the mean difference in learning achievements of students having high, average, and low working memory capacity
Result of the study demonstrated that students with high working memory capacity show better learning performance compared to those having average and low working memory capacity. Similarly, students having average working memory capacity show better learning progress than those having low working memory capacity. It is recommended that working memory capacity of the learners should be paid attention to improve students' learning performance.

Kye words: Working Memory, Learning Achievements, Mathematics.

Introduction

Mathematics enjoys key position in the comity of subjects. Throughout the world it is considered core component of the curriculum. Mathematics aids in developing learner's thinking and problems solving skills. Regrettably, lot of pupils struggle to understand mathematical ideas. They encounter difficulties when attempting to solve mathematical puzzles, which causes them to perform poorly. Learners fall short of their goal despite the intensive efforts of instructors and students in the field of study. So, they become irritated. In this regard, working memory—a cognitive ability plays a key role in addition to other elements. Working memory issues are blamed for students' failure. According to Alloway (2011) working memory has a significant impact on learning progress of pupils. The intricate cognitive apparatus that simultaneously processes and stores material is referred to as working memory. It has been suggested that working memory has a profound impact on learning. A growing body of research investigations establishes a significant link between working memory and learning math. Working memory refers to a limited capacity system responsible for the temporary storage and process of information while cognitive tasks are performed.

According to (Baddeley, 2007), working memory is the "the temporary storage system under attentional control that underpins… complex thought". Working memory, according to Cowan (2017), is a system of components that can hold a restricted quantity of data for restricted period while still making it easily accessible for ongoing processing.

Working Memory is a system that uses the information it stores to perform difficult cognitive activities like reading, thinking, and comprehending for a brief period. Working memory is a short-term memory storage system where connection is established between freshly acquired data and prior knowledge. In the words of Reisberg (1997) working memory seems to merit its name because it is the cognition's workplace. Working memory must be able to store and process all types of information that we can think about and pay attention to, including words, images, and abstract concepts, to fulfil its purpose. Johnstone & Al-Naeme (1991), demonstrated that a number of processes like Filtering of input, transient recall of sensory data, request to long-term memory for complementing input, screening and comparing, "sense creating," and sending of "formed" content to long-term memory are actively occurring in working memory.

Working memory is said to save restricted quantity of data for limited amount of time. Working memory capacity also varies with age. Working memory can only keep seven plus or minus two bits of data at a moment for a very brief period, according to Miller (1956). When a person reaches the age of 16, their working memory capacity rises by one unit every two years. Working memory capacity is fixed and cannot be increased.

Although on average working memory can hold 7 plus-minus 2 items, but in case processing is involved then storage capacity decreases to two or three units of information (Sweller et.al,1998), when human mind processes data i.e., when selection, comparison, and organization of information occurs this also occupies space, as a result fewer space is offered for storage of data in working memory (Eggen & Kahchak, 2007). Sweller et al. (1998) showed that people are usually able to deal with two or three data objects at a time when compelled to process information rather than just preserving it,

Various models of working memory have been proposed. According to the most famous model proposed by Baddeley and Hitch (1974), working memory consists of the following components:

1). Central Executive:

Baddeley (1996) described that central Executive performs following functions

i). It helps focus attention on task'

ii). It stores restricted amount of data for limited amount of time.

iii). It regulates higher order mental processes.

Central executive called heart of working memory plays key role in all mental tasks that need synchronization between data storage and intentional processing of information.

In (2007) Baadeley assigned to the central executive three attentional characteristics the ability to focus, split, transfer attention and bridging working memory and long-term memory.

2). Phonological Loop:

It is responsible for storage of spoken data. It repeats the received data constantly to avoid data decay through the process of mental rehearsal. For example, to recall a phone number we repeat it over again and again. Pisoni & Geers (1996) described that reading process utilizes Phonological Loop. Peng et al., (2018) demonstrated that on the basis of the performance of phonological loop predictions can be made regarding the reading skills of the learners. Children having working memory shortfalls, fail to perform better in reading skills.

3). Visuo-Spatial Sketchpad:

In the words of Klauer & Zhao (2004) it consists of two distinct systems, one holding visual things and the other being in charge of position. It functions as a link between sight, focus, and movement. It can combine both spatial and visual data from sight, contact, and speech into a unified representation (Baddeley, 2007).

4). The Episodic Buffer:

In (2006) Baddeley made an addition of another component called Episodic Buffer. According to Baddeley Episodic Buffer can hoard tiny amount of information. for restricted period. Baddeley further described that "that it holds episodes whereby information is integrated across space and potentially extended across time' and it is buffer in the sense that it serves as "an interface between a range of systems, each involving a different set of codes". Baddeley et al., (2011), mentioned that episodic buffer connects the information received from various working memory components into chunks. Information received from the loop, the sketchpad, or the LTM, or perception is merged into meaningful events by this component. It has restricted capacity. Here in buffer capacity is described in terms of chunks. Episodic buffer is responsible to connect data into chunks.

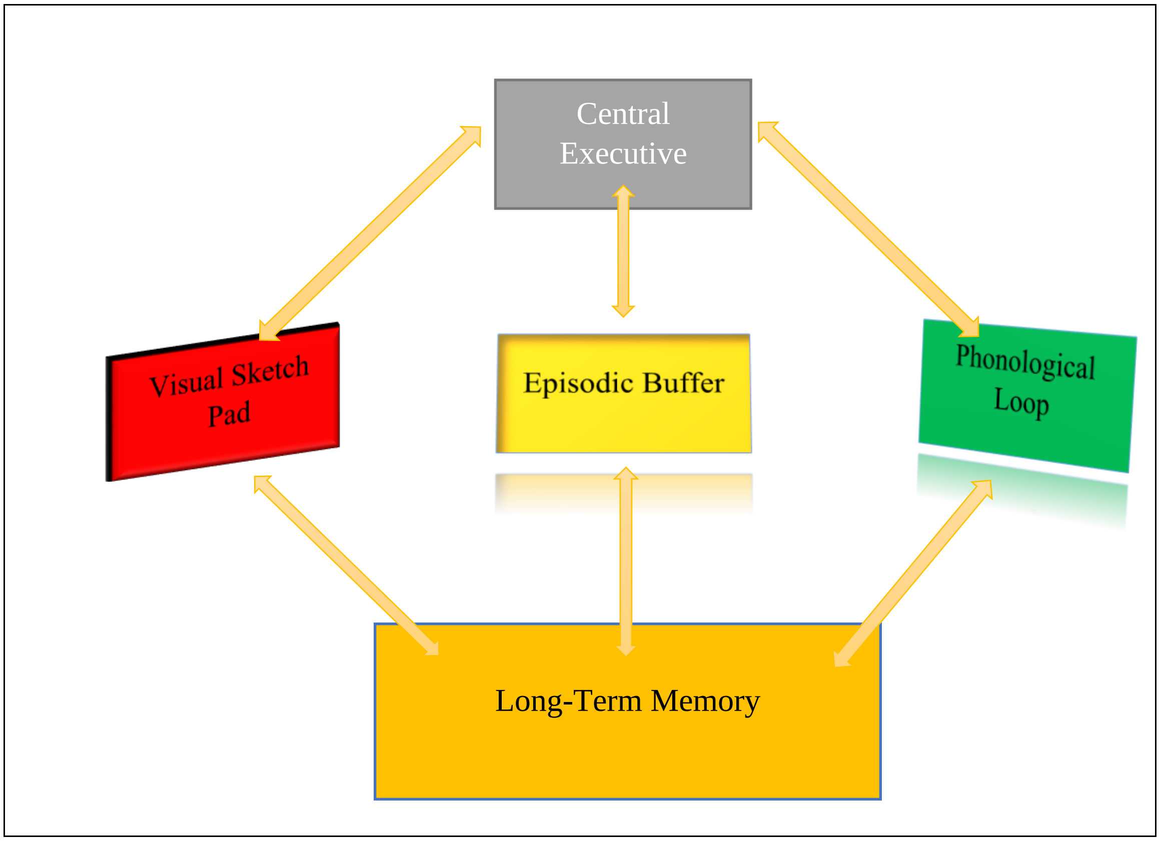

Figure 1: Baddeley's (2000) model of working memory

Working Memory and learning performance in Mathematics:

Mathematics is an important subject. Learning achievements in mathematics strongly depends on working memory ability. Mathematics is a complex subject; learners are required to utilize cognitive skills to solve mathematical problems. Research studies by Christou, (2001); Holems & Adams (2006); Alenezi (2004), Alenezi (2004), reveal that there is a remarkable connection between pupils' math expertise and their working memory capacity. Brainerd (1983) mentioned that mathematical calculations have a strong dependence on three working memory process.

Objectives of the Study:

Main objective of the study was to determine: The impact of Working Memory on students' learning achievements in Mathematics at secondary level.

Methodology:

It was experimental study designed to know the impact of working memory on learning performance of students in mathematics at secondary level. All public secondary schools for boys in district Kohat constituted population of the study. One public secondary school was selected using Purposive sampling technique for purpose of the study. So, sample of the study comprised 120 male students studying mathematics at secondary level.

To assess learning performance of students a test was prepared with the help of specialists in the subject (mathematics).

To quantify working memory capacity of the students, digit Backward Test (DBT) was used. DBT consisted of 14 series of digits. First sequence contained 2 digits and the last sequence contained 8 digits. Each series of digits was repeated twice for example there were two series of 2-digits (53 and 94), two series of three digits (647 and 592) two series of 4-digits (8694 and 4892) and so on two series of 8-digits. Researcher read each digit in a series with loud voice. There was break of 1 second between each digit. As soon as researcher finished reading a series students began to write heard digits in reverse order. Learners working memory was calculated by counting the series which were written correctly. As soon as there occurred two mistakes consecutively counting of the series was halted. For example, if a learner wrote 5 digits series correctly and failed to write 6-digit series correctly then his working memory was counted to be 5. Students had to complete each series within due time.

Working Memory	**Series**					
2	5	3				
	9	4				
3	6	4	7			
	5	9	2			
4	8	6	9	4		
	4	8	9	2		
5	3	6	4	9		
	7	5	8	2		
6	8	3	6	4	6	3

	6	2	8	5	9	5

Figure 2: Sample of DBT

Results of the Study:

Data collected was organized and summarized. Using descriptive and inferential statistics. Post Hoc Test was used for comparison of mean differences among three levels of achievements was used

Table 261: Results of Post Hoc Tests for Multiple Comparisons of mean differences among three levels of achievement by Tukey HSD

Levels of Achievement (1)	Levels of Achievement (2)	Mean Difference (1) -(2)	Standard. Error of Mean (SEM)	P values
HAs	AAs	4.10	1.077	.001
	LAs	8.00	1.077	.000
AAs	HAs	-4.10	1.077	.001
	LAs	3.90	1.077	.001

*. The mean difference is significant at the .05 level

Table 261 shows the results of mean differences in the learning achievements found between any two categories of students out of HAs, AAs, and LAs. It was found that learning achievement of HAs is significantly different from that AAs (p< .005, Sem=1.077). Results also reveal that learning achievement of HAs is significantly different from LAs.

Table shows that largest mean difference was found between the achievements of HAs & LAs (8). Similarly, the mean difference between HAs & AAs was found to be 4.10, which is greater than the mean difference found between AAs & LAs which is 3.90.

From the table No. 261 we can see the p-values for the following comparisons:

- HAs vs. AAs: p-value = .001
- HAs vs. LAs: p-value = .000
- AAs vs. LAs: p-value = .001

This table indicates that there is significant difference in the learning achievements of high achievers from average and low achievers. Similarly significant difference was found between the learning achievements of average and low achievers.

Conclusions:

Purpose of the study was to find out the working memory capacity of the students and to discover its impact on their learning achievements. Results of the study reveal that student having high working memory perform better compared to those having average and low working memories. Similarly, students having average working memory capacity perform better compared to those who have low working memory capacity. Thus, on the basis of results it is concluded that performance of students in mathematics at secondary level is closely related to their working memory capacity.

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