NSOU-OPEN JOURNAL **ISSN: 2581-5415**
Vol.4 No.1 (January 2021)
A multidisciplinary Online Journal of Netaji Subhas Open University, INDIA

Impact of School closure on learning mathematics and its memory due to COVID-19 pandemic

Shyamal Mistry
Assistant Teacher, Durgapur K.C.High School
E-mail: shyamal.spas.edu.in@gmail.com

Abstract

The main purpose of this study was to investigate the effects of school closure on learning mathematics and its memory due to COVID-19 pandemic, 2020.The study was conducted at Durgapur KC high School located in rural area in south 24 parganas, West Bengal. Only 5th-8th graded students were the population and among them only two hundred late childhood students aged 10-13 years were taken as sample by purposive sampling. Due to the pandemic situation in the academic year 2020, the progress of student's mathematics learning was assessed by direct interview of parents as well as knowing students opinion over mobile phone and by checking home tasks done by them. The result showed that due to the long closure of School in the pandemic scenario, the students could not practice mathematics in regular way by attending school. There was no pressure to do regular home tasks, no examination stress, no competition among peers, no reward and punishment from teachers, so the motivation level of most extrinsic or low motivated students towards learning mathematics became lagged. So they did not practice mathematics as much as they did when the School was open and their working memory was not used adequately. Thus student's working memory improvement was hampered. Beside, most of the math syllabus for the academic session (2020) remained incomplete. So the student lacked the mathematical memory foundation in LTM of particular class which would make the student suffering in the later classes. Mathematical knowledge upliftment of student was also being hampered due to lack of mathematical memory foundation. Overall, all cognitive abilities were hindered by insufficient active math practice for those students whose parents were uneducated or less educated and unable to teach math to them.

Key words: Mathematical memory, Math learning, Motivation, Working memory.

Introduction

School & Teacher: All schools in lockdown were closed and there was uncertainty about school open. Face to face learning between teachers and students barred so teachers had no influence on students. This situation had created a global learning crisis. According to UNESCO, "approximately 0.32 billion students in India had been affected by school closures due to the Covid-19 pandemic" (UNESCO 2020).Being not able to mix with friends so peer learning had also been stopped due to lack of peer competition, co-operation and discussion. In this situation, virtual classrooms had been opened in some private and government schools in most urban areas and in few rural areas. But in most of the cases of rural areas, especially in remote areas where students could not access internet facility (60% above, *source*: *West Bengal School survey in august,2020*)as a result they were unable to take advantage of online learning. In this situation, student's mathematics learning was a challenge for them.

Parents (educated vs. uneducated): So in this situation some students relied on private tutors. But the main support of all students was their parents and home schooling. Only educated parents could make progress in the learning of their children. This was possible if the parents were conscious and taught mathematics to their children by refraining from other activities such as watching television etc. These parents who actually took extra care of their child for online learning. When parents spent quality time in daily mathematical practice of their child, it helped to simulate the child to learn math. On the other hand, uneducated and less educated parents were not able to help their children's learning actively. Parents who were extremely stressed about the economic condition due to lockdown were also not supposing to take care for their children's education.(Horowitz, J. M. 2020).

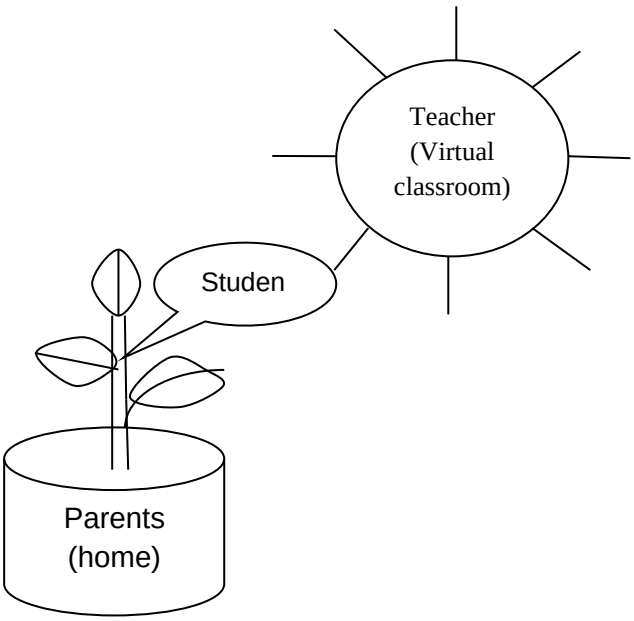

Figure 1: teacher, student & parents in COVID-19 lockdown

Students and their motivation: Pressure and stress in certain level is very much required for learning. All Govt aided, Govt, private schools were closed and first, second term & final examination were not conducted in West Bengal state. So the stress of math practice for exam preparation did not bother the students at all and did not foster learning. Previously there was no pass fail system in evaluation process moreover the West Bengal Government had declared that all students of this academic year (2020) would be promoted to the next class at the beginning of lockdown. This announcement had completely stopped the middle and lower achiever students from studying. But all students should continue self learning at their home.

Memory:"It is largely agreed that memory plays an essential role both in the learning of mathematics and in mathematical problem solving" (e.g. Leikin et al., 2013; Raghubar et al., 2010).Cognitive learning is a complete complex process that occurs by the formation of memories which is stored in Multi-store model of memory in the brain. The external mathematical stimuli enter into the sensory memory. If sufficient priority and attention are given on it then it enters short-term memory(STM), where it stores for short time.Then mathematical information are processed in STM and through encoding it enters and stores for long time into long-term memory(LTM).

Working memory: Working memory (WM)is the active part of STM, where active maintenance and simultaneous manipulation of mathematical information are occurred.According to Baddeley (2000) working memory is consists of four components as Central executive, phonological loop, visuospatial sketchpad and episodic buffer.Linguistic mathematical materials are stored temporarily in the phonological loop and visual or spatial structures are stored temporarily in visuospatial sketchpad through encoding from sensory register. With the help of these two slave systems, flow of mathematical information are holded and manipulated in the Central Executive component and long term memory are temporarily activated by the episode buffer. Active information coordination processes are done through retention and retrieval process between different components of WM and LTM by the episodic buffer. It is the key step for active mathematics

learning because recall or retrieval process plays an important role in formation of LTM (Baddeley, 2000).

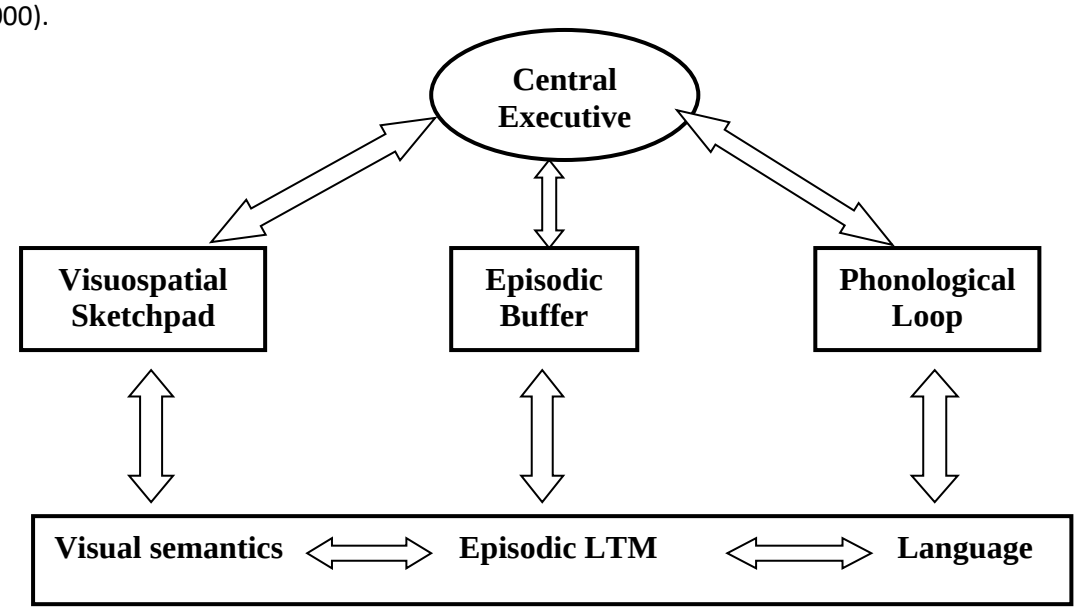

Figure 2: Baddeley's model of working memory (2000)

"Working memory plays an essential role in children's mathematical learning" (De Smedt et al., 2009). For example, when mathematical task like (1/2 + 1/3) is calculated by children, the following steps are performed in WM.

The visuospatial sketchpad retains pictures of 1/2, 1/3. The phonological loop retains the verbal explanation given by teacher. The episodic buffer recalls the names of 1/2, 1/3, + and rules of calculation from LTM. Then central executive component calculates new LCD, new numerator, and final step of addition;

(1/2+1/3= 3/6+2/6=3+2/6=5/6).

At last, new procedures are stored in LTM by episodic buffer.

Mathematical memory in LTM: During problem solving process, problems are solved in WM i.e. information processing is done in WM while mathematical procedures and problem solving methods are stored in long term memory (LTM). Thus Mathematical memory is shaped during mathematical activities and students memorize *mathematical generalizations* in their different subsystem of LTM (figure 3). According to Krutetskii, "*Mathematical memory is a memory for mathematical relationships, schemes of arguments, proofs and methods of problem-solving*" (Krutetskii, 1976, p.300)."Development of a student's mathematical knowledge may proceed episodically or semantically, or both." (Maciejewski, 2017). According to neuroscience, neurons make new physical connections and synapses with each other when a new long-term memory is formed in brain. This connection endures whether it's being used or not.

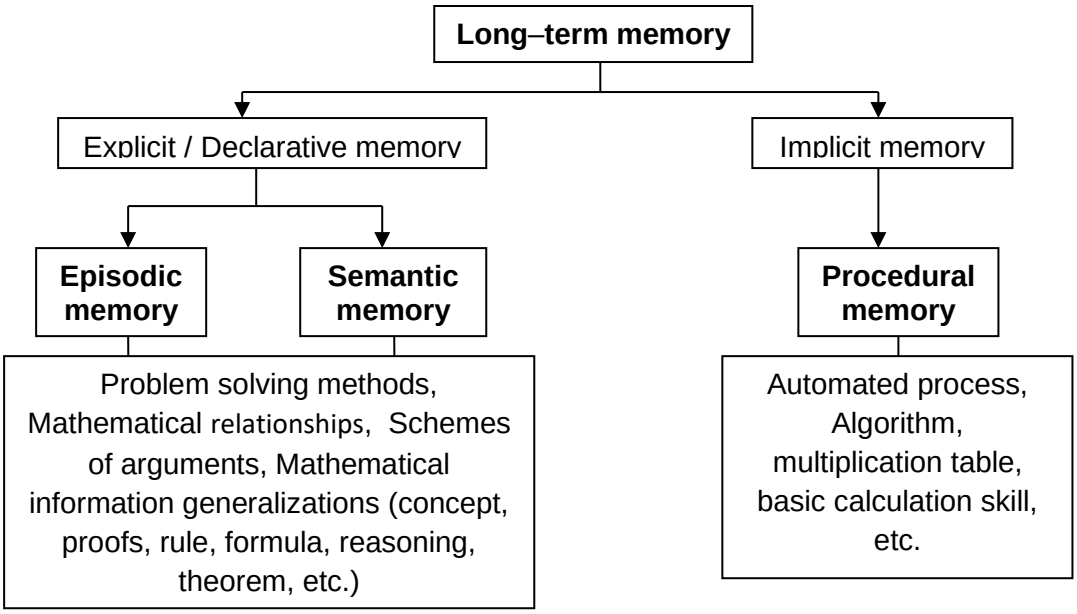

Figure3: Human long term memory system.

According to David Ausubel, meaningful learning occurs only when the student is able to associate the new information with the schema located in the long term memory i.e. with previous experience known as anchoring idea (Ausubel, 1960).
The objective of this study was to find out if students had learned math in lockdown and how the memory had been affected.

Review of related literature

Finn.A.Set. al. (2014) studied "Cognitive Skills, Student Achievement Tests, and Schools".Cognitive skills predict academic performance, so schools that improve academic performance might also improve cognitive skills. To investigate the impact of schools on both academic performance and cognitive skills, the researchers compared standardized achievement test scores with cognitive measures (Processing speed, working memory, fluid reasoning) of 1,367 students of 8th-grade in charter public schools. They found that math achievement had positive influence over school attendance but no influence could be found over cognitive skills.

Bonal.X. &González.S.(2020)studied "The impact of lockdown on the learning gap: family and school divisions in times of crisis". This study examined the impact of school closure on learning gaps among children of different social backgrounds in Catalonia, Spain. The researcher administered an online survey and collected 35419 responses from parents of children aged between 3 to18. They analysed that learning opportunities significantly differentiated. During lockdown period, Most of the Middle-class families were able to maintain a high standard of education while children from socially disadvantage were deprived from proper learning opportunities. both in terms of time and learning experiences (school work and maintenance of after-school activities).

Kuhfeld. M. et al (**2020**) studied "Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement."The objective of this study was to investigate the impact of school closure due to COVID-19 on student's academic achievement as summer learning lack. The researchers used research method regarding seasonal learning patterns when school was open versus close in the academic session of 2020. Projection suggested that school closure affects majorly on academic achievement, especially in mathematics. Students showed little learning gains from mathematics 37% - 50% of what was learned under normal circumstances.

De Souza-Talarico. U.N. et al (2007) studied "The influence of schooling on working memory performance in elderly individuals without cognitive decline".The purpose of this study was to find out how the working memory performances of elderly individuals were influenced by their education level. The present study was carried out among 40 healthy elderly individuals at the University of Sao-Paulo school of medicine (HC-FMUSP).The results showed that working memory performance was

depended on schooling. Better working memory performance was associated with higher levels of education, just as elder individual with higher education attained better working memory performance than those with lower levels of education.

Holmes.J. & Adams.W.J. (2007)studied "Working Memory and Children's Mathematical Skills: Implications for mathematical development and mathematics curricula". The purpose of the study was to analyse how the various components of working memory model were integrated with mathematical skills in children. 148 children aged 8-10 years had completed the working memory measurement test and age-appropriate mathematics test to determine the four mathematical skills defined by the National Curriculum for England. Out of three components of the WM model, Visuospatial sketchpad and central executive components were more effective in mathematical skill development than phonological loop in children. However, the relative contribution of each component did not vary much in different math skills.

St Clair-Thompson.H. et al (2010) studied "Improving children's working memory and classroom performance". The current study reveals that by using memory strategy training how a method can be explored to improve working memory. 254 children aged 5-8 years were selected to measure the three components of WM model (phonological loop, visuospatial sketchpad and central executive components) and mental arithmetic in the classroom. Fifty per cent of these children used Memory Booster, a computer game which taught them memory strategies over a period of 6-8 weeks. Then they were retested on memory & mental arithmetic after 5 months. The result showed that working memory strategy training improved the phonological loop, visuospatial sketchpad and central executive components of the multiple component model of working memory significantly.

Kosmidis.M.H. et al. (2011) studied "Literacy Versus Formal Schooling: Influence on Working Memory". This study was to examine whether the working memory performance of literate individual was relatively higher than that of illiterate cohort. The researchers administered five tests to measure the working memory on four groups of participants (school-educated literate, self-educated literate, functionally illiterate, illiterate). The finding showed that literate group performed more better than illiterate groups on all WM measure except the "Spatial Span" forward condition and "Remembering a New Route." It can be concluded that formal schooling as well as literacy enhances working memory, so there was a difference in working memory performance between literate and illiterate individuals.

Witt. M. (2011) studied "School based working memory training: Preliminary finding of improvement in children's mathematical performance." The study suggest that children who received working memory training made significantly greater gains in the trained working memory task, and in a non-trained visual-spatial working memory task, than a matched control group. Moreover, the training group made significant improvements in their mathematical functioning as measured by the number of errors made in an addition task compared to the control group. The findings, although preliminary, suggest that school-based measures to train working memory could have benefits in terms of improved performance in mathematics.

Calderón-Tena.C.O., Caterino.L.C. (2015) studied **"**Mathematics Learning Development: **T**he Role of Long-Term Retrieval." This study assessed the relation between long-term memory retrieval and mathematics calculation and mathematics problem solving achievement among elementary, middle, and high school students in nationally representative sample of US students, when controlling for fluid and crystallized intelligence, short-term memory, and processing speed. As hypothesized, structural equation modelling comparing elementary school students and middle and high school students revealed that long-term retrieval skills became a better predictor of both mathematics calculation and mathematics problem solving as age and grade increased.

Szabo.A. (2018) studied "Mathematical memory revisited: Mathematical problem solving by high-achieving students". This study assessed the role of mathematical memory in mathematical problem solving tasks. The researcher observed the two problem solving tasks done by high achieving students from secondary school one year apart with similar method but tasks were non routine for those students. The results showed that the participants used their mathematical memory mainly at the initial phase of problem solving process and they recalled only a small fragment of problem solving approaches to solve the math successfully.

Objective of the study:

Objective: To find out the impact of school closure on learning mathematics and its memory due to COVID-19 lockdown, 2020. Research question: How much learning mathematics & its memory were affected due to school closure?

Methods

Participants

All the 5th-8th graded school students of the academic session 2020 of Durgapur K C High School in south 24 parganas were the population of this study. Among them, two hundred late childhood students aged 10-13 years were selected as samples through purposive sampling method.

Materials

In the academic year of 2019, the motivation for learning mathematics of all students was measured with the help of Muthee achievement motivation inventory.

Procedure

Due to the pandemic situation in the academic year 2020, all schools in West Bengal were closed, but mid-day meal was given on a certain day of every month. In those days math home tasks were given for one month along with mid-day meal at Durgapur KC High School. Those tasks were solved by the students in their math exercise books which brought by their parents on the mid-day meal day of the next month. Teachers checked the mathematics assignments and handed over to their parents. Beside this, in those days, parents were asked if their children were learning math properly or not by *direct interview* method and the students were interviewed over mobile phone. Thus the progress of students' math learning had been measured in pandemic situation.

Statistical analysis

Gathered data was analyzed by using t test method by using SPSS.

Result

Research question: How much learning mathematics & its memory were affected due to school closure?

Table-1: Mean, SD, t test-value of mathematics home tasks done by intrinsically & extrinsically motivated students-

Independent variable	Dependent variable	N	Mean	Standard Deviation	t test value	
Intrinsic motivation	Percentage of mathematics home tasks done by students	43	79.88	11.347	4.722	Significance at 0.05 level .
Extrinsic motivation		157	20.45	4.621		

From table-1, Out of two hundred 5th -8th graded school students, 43 were intrinsically motivated students and 157 were extrinsically motivated students. Mean of Percentage of mathematics home tasks done by intrinsically & extrinsically motivated students are 79.88 and 20.45 respectively. t test value is 4.722 and it is significant at .05 level. So it can be concluded that there is significant difference between intrinsic & extrinsic motivation and mathematics home tasks done by 5th -8th graded school students in pandemic situation.

Students who are *work centred & intrinsically motivated* were practicing math for their own enjoyment at home confined in lockdown. In spite of this situation, those students continued their math practice though schools were closed.

The students who are *ego oriented & extrinsically motivated,* their motivation level should be enhanced by giving incentive or reward. This could be done by the teacher either by giving tangible extrinsic reward (i.e. tokens, medal, small prize, extra credit, stickers, and grade) or intangible intrinsic reward like offering recognition through praise for efforts when learners solve difficult math problems. But those students could not get external rewards due to school closure. There was lack of competition among peers. As they had no exam stress, their desire for learning math decreased time

to time. But in case of educated parents who were involved in their children's math learning directly were succeeded to teach them somehow.

Discussion

Effect on mathematical skill (working memory):

Mathematics is practice based subjects. So learners should practice math subject regularly. Student cannot improve his or her mathematical skills without practice. In school, students are being taught or practiced mathematics in an interesting way using TLM in the math class or in the math laboratory. This increase the mathematical working memory of students. School had been closed for a long time in this pandemic situation, so students were not learning or practicing maths in class and working memory of students was not being developed. Besides, there was no pressure to do homework every day and there was no peer competition so their working memory was not improving due to lack of active practice at home. As a result, they deteriorated their mathematical skill. Many of the students of primary classes and even upper primary classes could not recall the number table correctly and got stuck in basic mathematical operation that means their mathematical skill did not developed. Their condition became miserable due to school closure.

Effect on LTM: According to neuroplasticity, the neurons connections of brain's prefrontal and parietal cortex grow with math practice daily. But due to school closure, the students did not practice mathematics properly, so the nerve impulse transmission might be reduced for long time through the synapse of neurones and new connections might not have been formed adequately.

Effect on mathematical knowledge: Even bright students forget old math if they do not practice maths for a long time. They cannot recall mathematical knowledge from their episodic & procedural memory (Szabo.A, 2018). School were closed for a long time and students were not under the pressure of exam. So most of the students were not practicing old maths and were not learning new maths. As a result they were not gaining mathematical knowledge. If the students do not memorise the mathematical rules of the previous class, then they will not be able to solve the maths of next class due to the previous mathematical knowledge gap. If the mathematical knowledge foundation of a student is not strong from childhood then their mathematical schema fail to develop and eventually, they will not be able to solve math in higher classes. It also can be seen that many students have high logical mathematical intelligence and improved working memory but cannot solve math because their mathematical schema have not developed yet (Calderón-Tena.C.O., Caterino.L.C, 2015). The students did not cover the math syllabus of their class i.e. they did not learn the maths of a class for the whole academic session 2020 as the school was closed for a long time. As a result, the students were developing a permanent deficit in the mathematical knowledge foundation which would affect them in the next classes. It would have been better if the government had cancelled the 2020 academic session and in the 2021 academic session, the students would continue studying in their same class. Even if their age increases, there will not be any lack in mathematical knowledge and mathematical skill foundation for the whole life.

Conclusion

Motivation of students for learning mathematics had affected tremendously in the pandemic situation as school had been closed for a long time. Students were not learning or practicing maths in their class and working memory of students was not being developed as working memory is trainable in nature. Not only that but it also hampered mathematical memory foundation for a lack in active math practicing. It is also doubtful whether mathematical knowledge and mathematical skills were being formed or not.

References

[1]Ausubel, D.P (1960). The use of advance organizers in the learning and retention of meaningful verbal material.*Journal of educational Psychology*, 51, 267-272.

[2]Baddeley, A. (2000). The episodic buffer: a new component of working memory? *Trends in cognitive sciences,* 4, 417-423

[3]Bonal. X, González.S (2020). The impact of lockdown on the learning gap: family and school divisions in times of crisis.*International Review of Education.*UNESCO Institute for Lifelong Learning and Springer Nature B.V. 2020.https://doi.org/10.1007/s11159-020-09860-z

[4]Calderón-Tena.C.O., Caterino.L.C. (2015). Mathematics Learning Development: The Role of Long-Term Retrieval. *International Journal of Science and Mathematics Education*. DOI 10.1007/s10763-015-9655-0

[5]De Smedt, B., Janssen, R., Bouwens, K., Verschaffel, L., Boets, B., & Ghesquière, P. (2009).Working memory and individual differences in mathematics achievement: A longitudinal study from first grade to second grade. *Journal of experimental child psychology*, *103*(2), 186-201.

[6]De Souza-Talarico.U.N, Caramelli. P, Nitrini.R, Corrêa Chaves. E (2007).The influence of schooling on working memory performance in elderly individuals without cognitive decline.*Dementia & Neuropsychologia* 2007; 3:276-281 DOI: 10.1590/S198057642008DN10300009

[7] Finn.A.S, Kraft. M.A., West. M.R, Leonard.J.A,. Bish.C.E,Martin.R.E., Sheridan.M.A., Gabrieli.C.F.O., Gabrieli. John D. E. (2014) Cognitive Skills, Student Achievement Tests, and Schools.*Psychol Sci*. 25(3):736–744. doi:10.1177/0956797613516008.

[8]Holmes.J & Adams.W.J (2007). Working Memory and Children's Mathematical Skills: Implications for mathematical development and mathematics curricula.*Educational Psychology: An International Journal of Experimental Educational Psychology.*Volume 26, 2006 - Issue 3. Pages 339-366

[9]Horowitz, J. M. (2020, April 15). Lower-income parents most concerned about their children falling behind amid COVID-19 school closures*. Pew Research Center*.https://www.pewresearch.org/facttank/2020/04/15

[10]Krutetskii, V. A. (1976). The psychology of mathematical abilities in schoolchildren. Chicago, IL: The University of Chicago Press.

[11]Kuhfeld, M, Soland.J, Tarasawa.B, Johnson.A, Ruzek.E, and Liu.J (October, 2020). Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement*. Educational Researcher,* Vol. 49 No. 8, pp. 549–565 DOI: 10.3102/0013189X20965918

[12]Leikin, M., Paz-Baruch, N., & Leikin, R. (2013). Memory abilities in generally gifted and excelling-in-mathematics adolescents.*Intelligence, 41*(5)*,* 566–578.

[13]Maciejewski. W (2017).Mathematical knowledge as memories of mathematics.*PME* 41 – 2017. In Kaur, B., Ho, W.K., Toh, T.L., & Choy, B.H. (Eds.). Proceedings of the 41st Conference of the International Group for the Psychology of Mathematics Education, Vol. 3, pp. 209-216. Singapore: *PME*.

[14]Mary H. Kosmidis, Maria Zafiri1, Nina Politimou (2011) Literacy versus Formal Schooling: Influence on Working Memory. *Archives of Clinical Neuropsychology* 26 (2011) 575–582

[15]Raghubar, K. P., Barnes, M. A., & Hecht, S. A. (2010). Working memory and mathematics: A review of developmental, individual difference, and cognitive approaches.*Learning and Individual Differences, 20*(2), 110–122.

[16] St Clair-Thompson.H.,Stevens.R,Hunt.A,Bolder.E (2010). Improving children's working memory and classroom performance.*Educational Psychology: An International Journal of Experimental Educational Psychology.* Volume 30, 2010 - Issue 2. Pages 203-219.

[17] Szabo.A. (2018). Mathematical memory revisited: Mathematical problem solving by high-achieving students. *CERME 10*, Feb 2017, Dublin, Ireland.hal-01935805. HAL Id: hal-01935805 https://hal.archives-ouvertes.fr/hal-01935805Submitted on27Nov2018.

[18]Witt M. (2011). School based working memory training: Preliminary finding of improvement in children's mathematical performance. *Advances in Cognitive Psychology.* 7:7–15. [PubMed: 21818243]

[19]UNESCO. (2020). School closures caused by Coronavirus (Covid-19). Retrieved May 8, 2020, from https://en.unesco.org/covid19/educationresponse.