ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research

Vol. 04, Issue 12, pp.3293-3298, December, 2017

RESEARCH ARTICLE

ENHANCING STUDENTS' WORKING MEMORY CAPACITY AND ACHIEVEMENT IN CHEMISTRY THROUGH SPACED LEARNING

***Lomalinda J. Clores**

Teacher Education Department, Cavite State University-Naic Campus, Cavite Philippines

ARTICLE INFO

Article History:

Received 20th September, 2017

Received in revised form 28th October, 2017

Accepted 19th November, 2017

Published online 30th December, 2017

Keywords:

Achievement in Chemistry, DSBT, Spaced Learning, Working Memory Capacity.

ABSTRACT

This study investigated the effect of spaced learning method on the students' working memory capacity and achievement in Chemistry. It sought to answer these objectives: (1) identify the working memory capacity profile of the students; (2) determine the achievement of the students in Chemistry before and after exposure to spaced learning; (3) ascertain if there is a difference between the pretest and posttest mean scores in the achievement test; (3) determine the pretest and posttest mean scores across working memory capacity level; (4) find out if there is a difference in the gain scores across level; and (6) assess the students' experiences on the use of spaced learning. This study utilized the single group pretest–posttest pre–experimental design. One intact class consisted of 31 students was the respondents. The instruments include: (1) achievement test; (2) spaced learning lessons; (3) Digit Span Backward Test; (4) students' experience survey; and (5) observation checklist. To analyze the data, weighted mean, paired t – test, Kruskal Wallis and Wilcoxon Signed Rank tests were used. The findings showed that spaced learning tends to enhance the student's performance in Chemistry. However, students across working memory capacity level exhibited no significant difference between their pretest and posttest mean scores. Besides, as reflected in the gain scores, it appeared that the method highly favored the intermediate and low processors. As perceived, spaced learning is interesting and enjoyable. Students become active and confident in expressing their thoughts since they feel rested and relaxed.

INTRODUCTION

Neuroscientific findings and discoveries are transforming science education. These advances in neuroscience make the basis of learning clear and require changing our conventional approaches. According to Tuazon (2016), anything and everything educational is neurological and should be brain-based compliant to learn efficiently. Consequently, people in the academe are faced with a lot of challenges as to how they can promote meaningful learning. Kelly (2000) stated that much of what we teach isn't remembered by pupils, that the long term value of much education is hardly apparent to pupils, and a similar answer might apply to the neuroscientific perspective: much education doesn't have the characteristics that demonstrate its adaptive value in order to justify its conversion to long-term memory. Working memory capacity differs from individual to individual. Students with working memory difficulties can hold fewer pieces of discrete information in their mind at any given moment. They hear what the teacher said, or see what is presented, but as more information overwhelms their memory system they lose previous information needed to successfully complete the task. Once information is lost it is not likely to be retrieved. It is easy to see how the student can become frustrated and consequently stop paying attention.

***Corresponding author:* Lomalinda J. Clores,**

Teacher Education Department, Cavite State University-Naic Campus, Cavite Philippines.

Chemistry students with working memory problems are "missed". They are mis-diagnosed or mistaught. If this happens to learners, they may develop low self-esteem and self-concept. They may become discouraged, thus, unable to excel and succeed in their studies. If teachers are able to address these working memory capacity issues successfully, then they can produce excellent learners. At times, many of the learning activities that a science student is engaged with impose quite considerable burdens on working memory. Activities in chemistry often require the student to hold in mind some information while doing something that for them is mentally challenging. These are the kind of activities on which student with poor working memory struggle with most, and often fail to complete them properly because they have lost from working memory the crucial information needed to guide their actions. As a result, the student may not get the learning benefit of successfully completing an activity, and this slows down his/her rate of learning and so typically will make poor general academic progress. There is now an increasing body of evidence which suggests that once the science teacher knows that a student has poor working memory and has identified his/her working memory capacity, it is vital to find ways to overcome these difficulties, in order to ensure that learning can be maximized. According to Gathercole and Alloway (2009), frequently repeating important information is a good practice with students with working memory deficits. Spaced learning was developed on 2011 at Monkseaton High School located in the United Kingdom. It is a method of creating long term memories through intense learning repeated three times, with two ten minute's spaces in between. It is built upon inducing permanent changes in the brain of learners. Related researches in science have found that in order to promote long-term retention of knowledge, students should receive spaced re-exposure to previously-learned information. Spacing helps minimize forgetting (Gathercole and Alloway, 2009). When the teacher gives learners a rest between learning sessions, the teacher may limit their learning fatigue and may speed up their rates of learning thus improving their academic performance. It is in this light that the researcher decided to investigate the effect of spaced learning on the students' working memory capacity and achievement in chemistry, thus, contributing to the body of knowledge by way of introducing a new methodology in teaching chemistry. The outcome of this study may change students' perception about chemistry and may provide them awareness to assess their abilities to hold in mind and mentally manipulate information during thinking and reasoning tasks over short periods of time in order to learn and perform better.

Statement of the Problem

The main purpose of the study is to determine the effect of spaced learning on the students' working memory capacity and achievement in Chemistry. More specifically, this study was conducted to answer the following questions:

- What is the working memory capacity profile of the students?
- What is the achievement of the students in Chemistry before and after exposure to spaced learning?
- Is there a difference between the pretest and posttest mean scores in the achievement test?
- What is the pretest and posttest mean scores in the achievement test across working memory capacity level?
- Is there a difference in the achievement test gain scores across working memory capacity level?
- What are the students' experiences on the use of spaced learning?

Theoretical Framework

Alan Baddeley and Graham Hitch (1974) suggested a model showing the dynamic concept of "working memory". They were able to propose this model after performing a true–false task. In this task, participants were given a string of six to eight digits (which according to Miller should fill the capacity of short-term memory) to repeat immediately after each true–false task. If the short-term memory store is critical for performing complex cognitive tasks and there is only one short-term store available, then performance on the reasoning task should drastically decline with the addition of the digit-memorization task. However, this was not the case. The participants took slightly longer to answer questions but made no more errors when also holding digit strings in short-term memory. From these results, Baddeley and Hitch argued that, there are multiple systems available for short-term storage and that these storage systems are coordinated by the actions of a central control system that flexibly handles memory allocation and the balance between processing and storage. Their model consists of two short-term stores and a control system.

The three components of the Baddeley-Hitch model interact to provide a comprehensive workspace for cognitive activity. The phonological loop was occupied storing the digits, and the visuospatial scratchpad did much of the cognitive work in evaluating the spatial relationships in the true–false task. Coordination was supplied by the central executive, which transformed information from reading the statement (essentially in the verbal store) into a mental image on the visuospatial scratchpad. These interactions meant that performance on the reasoning task did not decline greatly when digit memorization was added.

REVIEW OF RELATED LITERATURE

Working Memory

The term 'working memory' was used by psychologists as the ability to hold in mind and mentally manipulate information over short periods of time. Students who have trouble with their working memory skills will often have difficulty remembering their teachers' instructions, or completing other tasks that involve actively calling up important information. One of the important concepts to understand about working memory is that it is limited in capacity, which means that an individual cannot store and manipulate endless amounts of information. Therefore, the types of thinking and remembering tasks a person can undertake will be constrained by working memory resources. Working memory also limits, to some degree, the types of things one can handle concurrently. Even there are some types of tasks that can be carried out at the same time, other types of tasks compete for the same resources within the working memory system and, therefore, interfere with each other. Working memory is vital because it underpins abilities in many other areas such as reasoning, learning and comprehension.

Gathercole and Alloway (2009) stated that because working memory's storage capacity is limited, it can often fail individuals. Two of the most common situations that lead to working memory failure are distractions and doing something else while trying to hold information in working memory. Information that is lost from working memory cannot be recovered. The only option in this situation is to begin again. Individual differences and variances in working memory have helped to shed some light on why working memory performance varies in individuals (Davis, 2011). Individual differences in working memory can be explained by storage capacity. A fundamental characteristic of working memory is that is has a limited capacity which constrains cognitive performance. Individuals with a greater capacity tend to perform better on cognitive tasks than individuals with a lesser capacity (Conway, 2007). According to Nalliah (2012), working memory capacity is the focus for the differential characteristics seen among individuals in relation to academic achievement in chemistry.

Spaced Learning

Spaced learning originates in neuroscientific research that shows the process of creating long –term memories. A spaced learning session consists of three repetitions of a compressed module or course separated by 10-minute spaces with distractor activities. The first intense learning is often like a lecture in which the teacher presents a large body of information, usually supported by a PowerPoint presentation.

The second input focuses on recall, or review so students might be presented with the same PowerPoint presentation, missing many key words, where students recall the answers. The final input focuses on understanding, so students often carry out a task that requires the knowledge or skills they have just acquired or create a completed version of the second PowerPoint presentation. This process of rapid structured repetition, separated by 10 spaces, embeds the information in the long-term memory. Fields (2005) led a team investigating the science behind how the brain actually creates a long-term memory. The biological basis of a memory is a pathway of cells linked together within the brain. Fields' team focused on how each cell was 'switched on" and became linked to other cells. Their experiments demonstrated that it is the manner in which the brain's cells are stimulated that causes them to 'switch on' and link together. Surprisingly, constant stimulation of the cell did not make the cells switch on. Stimulation had to be separated by gaps when the cell was not stimulated. The breakthrough came when the team 'began to realize that the important factor was time'. The length of stimulation was not vital, but the gap between stimulations was, and 10-minute gaps in between the stimuli triggered long-term memory processes.

Thalheimer (2006) stated that spacing effect occurs when learners were presented with a concept to learn, wait some amount of time, and then present the same concept again. Vlach and Sandhofer (2012) said that spacing effect refers to the finding that long-term memory is enhanced when learning events are spaced apart in time, rather than massed in immediate succession. In their studies, memory is typically tested by presenting learners with lists of words on two learning schedules, massed and spaced. Massed learning schedules present participants with learning events in immediate succession. In contrast, spaced learning schedules distribute learning events across time. Results of researches have consistently demonstrated that learners have higher long-term performance on spaced learning schedules than massed learning schedules. Spacing involves repetitions. Cepeda and Kang (2008) suggested that in order to promote long-term retention of knowledge, students should receive spaced re-exposure to previously-learned information. Particularly if the goal is long-term retention, it may be beneficial to review this information after a time period. Kelley (2009) stated that studying information across two or more sessions that are separated in time often produces better learning than spending the same amount of time studying the material in a single session.

MATERIALS AND METHODS

Research Design

The study employed the single group pretest–posttest pre–experimental design. Quantitative analysis was used in describing the students working memory capacity level and interpreting the results of the achievement test scores to measure the effect of spaced learning. Qualitative analysis was used to determine the students' experiences on the use of spaced learning.

Respondents and Research Locale of the Study

The study was conducted during the second semester of school year 2015 – 2016 at Cavite State University - Naic Campus located in Bucana, Naic, Cavite. The researcher handles two sections of Bachelor of Science in Fisheries (BSFi), the campus flagship program. Through convenience sampling technique, Section A was selected as the respondents of the study. The said section was composed of heterogeneous students who were perceived by the researcher to be promising, participative and punctual. The sample consists of 31 students enrolled in organic chemistry class. There are 21 female and 10 male students with ages ranging from 17 – 22 years old.

Research Instruments

In the conduct of the study, the researcher used 5 research instruments namely: (1) spaced learning lessons, (2) Digit Span Backward Test (DSBT), (3) Chemistry achievement test, (4) students' experience survey, and (5) observation checklist. DSBT was adapted while all other instruments were developed and experts validated.

Research Method

The study followed five phases in the in the data gathering process. The *first phase* was the development and validation of the research instruments. Upon completion of these instruments, permission to undertake the study was requested from the dean of CvSU Naic. Preliminary activities were also conducted to acquaint the students about spaced learning and to familiarize them with the sequence of the lesson presentation.

The *second phase* of the study was the administration of the Digit Span Backward Test to the respondents. This test determines the students' working memory level as to high processor (HP), intermediate processor (IP) or low processor (LP).

The *third phase* was the administration of the pretest to students on selected topics in Chemistry. The test consists of 30 questions that were validated by experts. The result of the test was recorded for comparison purposes.

The *fourth phase* was the study proper. The conduct of actual instruction employing spaced learning. To ensure that the method was properly implemented, the director for curriculum and instruction, department heads, chemistry professors were invited to observe and describe what transpired in the classroom using the observation checklist.

For the *final phase* of the study, the researcher administered the posttest to the respondents as well as the experiences survey questionnaire to gather feedbacks from the students.

RESULTS AND DISCUSSION

Working Memory Capacity of the Students

The DSBT was used to determine the working memory capacity level of the students. The score of each student in the DSBT was analyzed. A score ranging from 5 – 7 on the DSBT was classified as high processor (HP), a score of 4 as intermediate processor (IP), and a score ranging from 1 – 3 as low processor (LP). The high and low processors are those students who have more and limited capacities to hold in mind and mentally manipulate information over short periods of time, respectively. Intermediate processors are those students who can temporarily store in mind and mentally manipulate information over short periods of time.

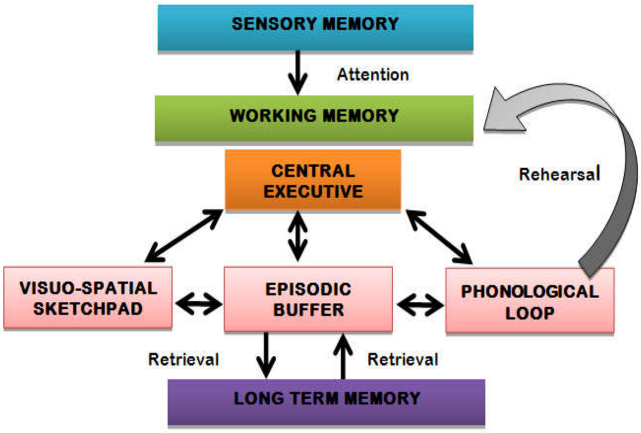
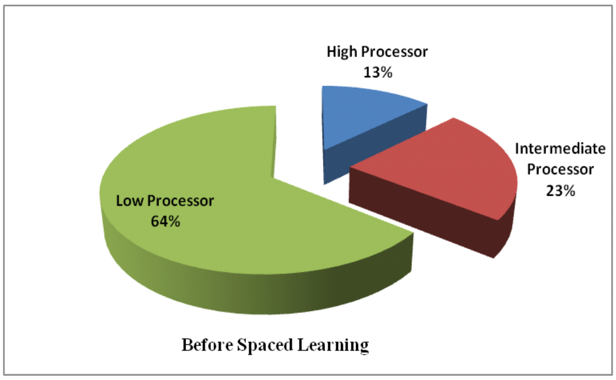


Figure 1. The Baddeley-Hitch Model of Memory

Figure 2 presents the working memory level of the respondents before and after their exposure to spaced learning. From 31 respondents, 20 (64%) were classified as low processors, 7 (23%) were categorized as intermediate processors and 4 (13%) were grouped as high processors before exposing the students to spaced learning. It is evident that more than half of the students have a low working memory capacity. However, after exposure to spaced learning, there is a change in the classification of the respondents' working memory capacity level. As revealed in Figure 2, out of 31 respondents, there were now 28 (90%) high processors, 3 (10%) intermediate processors and 0 (0%) low processors.



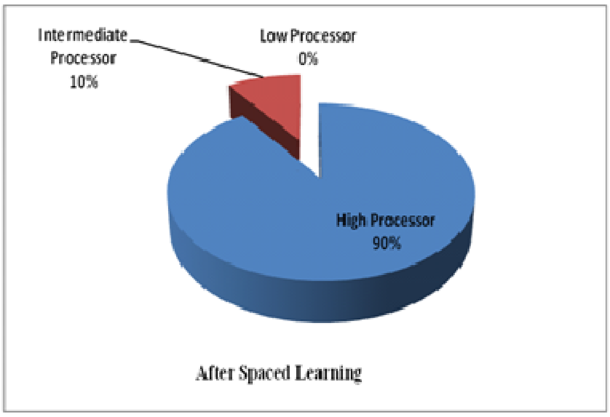


Figure. 2. Working memory level of the respondents before and after exposure to spaced learning

This indicates that the number of high processors increased by 24 (77%). On the other hand, the number of intermediate processors decreased by 4 (13%) which shows that these students were transformed into high processors after exposing them to spaced learning. The result also shows that 20 students categorized as low processors were changed into either intermediate or high processors.

Students' Performance in the Chemistry Achievement Test

The same pretest and posttest were given to the respondents and their gain scores were computed and compared. Table 1 presents the summary of the descriptive statistics of the pretest and posttest scores of the students in the chemistry achievement test in terms of mean scores, standard deviation, highest and lowest scores. As shown in Table 1, the highest score in the pretest is 16 and the lowest score is 4 while in the posttest, 24 and 9 are the highest and lowest scores, respectively.

Table 1. Descriptive statistics in the achievement test scores

	Highest Score	Lowest Score	Mean	SD
Pretest	16	4	9.807	3.794
Posttest	24	9	16.484	2.798

The standard deviations of 3.794 in the pretest and 2.798 in the posttest indicate that the scores of the students in the pretest is more scattered compared to their scores in the posttest. This implies that the students performed better when taught using spaced learning. This result conforms to the statement of Vlach and Sandhofer (2012) that spaced learning may be one contributing factor to the success of other educational interventions that have demonstrated success in promoting learning.To determine if there is a significant difference between the pretest and posttest mean scores of the students before and after their exposure to spaced learning, the paired *t*-test was employed.

Table 2. Paired t-test between students' pretest and posttest mean scores

Pair	Mean	Mean Difference	SD	df	*t*-value	*p*-value
Posttest Pretest	9.807 16.484	6.677	3.794 2.798	30	8.435	0.000

$p<0.05$

Table 2 shows that there is a significant increase in the mean scores obtained by the students, from 9.807 to 16.484 in the pretest and posttest, respectively. The *t*-test for paired samples results to a *t*-value of 8.435 and a *p*-value of 0.000. The *p*-value is less than the level of significance set in the study ($p<0.05$). This means that the difference between the posttest and pretest is significant. The use of spaced learning activities promoted better learning of the students. This result conforms to the statement of Vlach and Sandhofer (2012) that long term learning is promoted when learning events are spaced out in time, rather than presented in immediate succession. Moreover, the same result also agrees with the findings of Kelley and Whatson (2013) that long term-memories of an academic course can be created rapidly through spaced learning.

Chemistry Achievement of Students with Varied Working Memory Capacity

To determine the pretest and posttest mean scores in the achievement test across working memory capacity level, Kruskal Wallis was used. In this study, there are three groups which are independent, and the samples are not normally distributed or the samples do not have equal variances. The respondents of the study were pretested to determine their prior knowledge on the subject matter before exposing them to spaced learning.

Table 3. Kruskal Wallis test of the pretest mean scores across working memory capacity level

Working Memory Level	Pretest Memory	SD Mean	Variance	Chi-Square	*p* -value
High Processors	9.500	1.732	3.000	3.179	0.204
Intermediate Pro	11.429	2.370	5.619		
Low Processors	9.300	2.975	8.853		

p>0.05

Table 3 shows the mean scores in the pretest of the students classified as high, intermediate, and low processors. The results reveal that high processors obtained 9.500; intermediate processors achieved 11.429 while the low processors got a mean score of 9.300. The standard deviations of the three scores are equivalent to 1.732, 2.370, and 2.975, respectively. Chi-Square analysis revealed a value of 3.179 and *p* – value of 0.204. The computed *p* – value associated with the test statistics is greater than the level of significance set in the study (*p>0.05),* therefore the difference in the mean pretest scores of the three groups is not significant.

Table 4. Kruskal Wallis test of the posttest mean scores across working memory capacity level

Working Memory Level	Posttest Mean	SD	Variance	Chi-Square	*p* -value
High Processors	18.250	5.679	32.250	0.535	0.765
Intermediate Pro.	16.714	3.302	10.905		
Low Processors	16.300	3.649	13.313		

p>0.05

The same achievement test was given to the respondents after their exposure to spaced learning. Table 4 presents the results of the posttest mean scores of the three groups of students. As shown in Table 4, the mean scores in the posttest of the students classified as high, intermediate and low processors are 18.250, 16.714 and 16.300 respectively. It can be noted that the high processors got the higher standard deviations equivalent to 5.679, 3.302 for the intermediate and 3.649 for the low processors. Chi-Square analysis revealed a value of 0.535 and *p* – value of 0.765. The computed *p* – value associated with the test statistics is higher than the level of significance set in the study (*p>0.05),* therefore the difference in the mean posttest scores of the three groups is not significant. This result indicates that students with varied working memory level, performed equally well after their exposure to spaced learning. This result agrees with the statement of Vallente that students' working memory capacity has a significant impact on their achievement. Significant results may be obtained by conducting further studies to a larger group of samples.

Table 5. Wilcoxon Signed Rank test of the achievement test gain scores across working memory capacity

Working Memory Level	Pretest Mean	Posttest Mean	Gain Score	Z-value	*p*-value
High Processors	9.500	18.250	8.750	-1.826	0.068
Intermediate Pro.	11.429	16.714	5.285	-2.375	0.018
Low Processors	9.300	16.300	7.000	-3.828	0.000

p>0.05

Table 5 shows that gain score obtained by the high processor is equivalent to 8.750 points, from the 9.500 and 18.250 mean scores of the pretest and posttest, respectively. The Wilcoxon Signed Rank Test results to a *Z* – value of -1.826 and a *p* – value of 0.068. The computed *p* – value is greater than the level of significance set in the study (*p>0.05)*. This indicates that there is no significant difference in the mean gain scores of the high processors in the achievement test. This could mean that the working memory capacity level of the four high processor students had no effect in their achievement in Chemistry. Apparently, different findings can be drawn for the intermediate processors. It can be noted in the table that they obtained a gain score of 5.285 points; from the 11.429 and 16.714 mean scores of the pretest and posttest, correspondingly. The computed *p* – value is less than the level of significance (*p<0.05)*. This indicates that there is significant difference in the mean gain scores of the intermediate processors in the achievement test. In the same table, it is also shown that there is a difference between the pretest, 9.300 and posttest, 16.300 mean scores of the low processors. This group of learners got a gain score of 7.000 points. The computed *Z* – value and *p* – values are -3.828 and 0.000, respectively. The *p* – value is also less than the level of significance set in the study (p<0.05), therefore the gain scores of the low processors in the achievement test is significant. This result indicates that, intermediate and low processor students achieved better when exposed to spaced learning method. Inasmuch as spaced learning made use of a number of breaks, relaxed their mind, it could be speculated that this method had established a learning atmosphere suitable to the cognitive level of the students.

Students' Experiences on the use of Spaced Learning: Students' experiences on the use of spaced learning were gathered through the survey questionnaire. The survey consists of 10 statements and utilized a 4–point Likert scale with corresponding qualitative interpretations. It was given after the posttest of the study. Table 6 summarizes the results of the survey. Table 6 shows the mean of students' responses to the experience survey.

Table 6. Students' experience survey on the use of spaced learning

Statement	Weighted Mean	Interpretation
• Spaced learning helped me understand how bonds are formed, how chemical formula is written and how hydrocarbons are named	3.30	Agree
• The presentation of the concepts using spaced learning was clear and suited to my needs	3.40	Agree
• I could easily store and recall key information using spaced learning	3.20	Agree
• I enjoyed doing activities during breaks.	3.70	Strongly Agree
• The activities allowed me to rest and relax.	3.60	Strongly Agree
• The time allotment was adequate for each lesson.	3.40	Agree
• I was more mentally active in the learning process when spaced learning was used	3.30	Agree
• Spaced learning inspired and encouraged me to learn more topics in Chemistry	3.30	Agree
• I developed confidence in expressing my thoughts and ideas.	3.40	Agree
• I wish my teachers would use paced learning in a regular classroom next time.	3.10	Agree
Overall Weighted Mean	3.40	Agree

The overall mean rating of 3.40 was interpreted as agree. This means that spaced learning is an effective method in teaching chemistry to enhance students' working memory capacity and performance. To further validate this result, extracts of the respondents' actual comments on the use of spaced learning were processed. Evidently, spaced learning helped them understand topics in chemistry. This method facilitated students' learning easily. It allowed them to think critically and made them more mentally active in the learning process. Student felt rested and relaxed since spaced learning is coupled with activities in which they believed enjoyable.

Conclusion

Based on the findings of the study, the following conclusions were drawn:

- Most of the students classified as low and intermediate processors were transformed to high processors after their exposure to spaced learning.
- The use of spaced learning tends to enhance the performance of students in Chemistry.
- The high, intermediate and low processors performed equally well before and after their exposure to spaced learning.
- The use of spaced learning activities favors the working memory level of the intermediate and low processors.
- High, intermediate and low processors have a favorable view on the use of spaced learning. They found the activities during breaks enjoyable allowing them to rest and relax thus, students developed confidence in expressing their thoughts and ideas.

Recommendations

- Encourage teachers to adopt innovative teaching methods such as spaced learning to help their students improve their achievement.
- Conduct similar studies covering other topics in chemistry to validate the result of this study.
- A similar study using spaced learning on students' achievement and working memory capacity may be conducted in other fields of science. Moreover, it is recommended that this study may be replicated in other schools to obtain comparative results.

REFERENCES

Baddeley, A. 2007. Working memory, thought, and action. Retrieved from http://www.onlinelibrary.wiley.com/doi/10.1002/9781118323373.refs/pdf.

Baddeley AD, Hitch GJ. 1974. Working memory. In The Psychology of Learning and Motivation: Advances in Research and Theory, ed. GA Bower, pp. 47–89. New York: Academic

Cepeda, and Kang 2008. Spacing Effect in Learning. Retrieved from http://laplab.ucsd.edu/articles/ Depeda%20et%20al%202008_psychsi.pdf.

Conway, A. 2007. Variation in working memory. Retrieved from http://www.englelab.gatech.edu/publications.html

Davis, D. 2011. Identifying Working Memory Capacity: A Study of Two Working Memory Assessment Tools. Retrieved from http://www2.uwstout.edu/content/lib/thesis/2011/2011davisd.pdf

Fields, R. 2005. Spaced Learning: Making memories Stick. Retrieved from http://www.innovationunit.org/sites/default/files/Spaced_Learning-downloadable_1.pdf

Gathercole, S. And Alloway, T. 2009. Understanding Working Memory. A Classroom Guide. Retrieved from http://www.york.ac.uk/res/wml/Classroom%20guide.pdf

Kelley, P. 2009. Spaced Learning. A harbinger of a paradigm shift in education. Retrieved from http://makingminds.net/wp-content/uploads/2014/02/Kelley-2009-Spaced-Learning.pdf

Kelley P. and Whatson D. 2013. Making Minds: what's wrong with education-and what should we do about it? Routledge, London/New York.

Nalliah, S. 2012. The influence of working memory capacity on academic achievement of final year medical students. Retrieved from http;//www.reviw_siva_s87-s102.pdf

Thalheimer, W. 2006, February. Spacing Learning Events Over Time: What the Research Says. Retrieved from http://www.work-learning.com/catalog/

Tuazon, D. 2016. Brain-Based Learning.

Vlach, H. and Sandhofer, R. 2012. Distributing Learning over Time: The Spacing Effect in Children's Acquisition and Generalization of Science Concepts.

****