Journal of Education and Policy Review **© 2016 Cenresin Publications** *Volume 8, Number 2, 2016*
www.cenresinpub.com
ISSN: 2277-0100

THE EFFECTS OF SHORT TERM MEMORY AND READING COMPREHENSION ON STUDENTS' PERFORMANCE IN CHEMISTRY IN JERE, BORNO STATE, NIGERIA

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Abstract: *Working memory relates to an individual's ability to attend to verbally- or visually-presented information, to process information in memory, and then to formulate a response. Difficulties with working memory may make the processing of complex information more time-consuming, draining a student's mental energies more quickly and perhaps result in more frequent errors on a variety of tasks. Short-term memory is important to reading achievement. Reading comprehension, involving long reading passages, may be affected by skills specifically related to working memory. Basic word reading may be impacted by deficits in short-term memory because it may interfere with acquiring letter and word identification skills. The objective of this study is to extend the current research linking reading performance to academic performance by examining the relationship between reading and performance in chemistry at the senior secondary (SS) I and II levels. Two research question and a hypothesis guided the study. The result of the study found out that: there is significant relationship between recall and students' performance in chemistry; there is significant relationship between digit span and students' performance in chemistry; there is significant relationship between comprehension and students' performance in chemistry; there is no significant relationship between spelling and students' performance in chemistry; there is significant relationship between vocabulary ability and students' performance in chemistry and that there is significant relationship between all the five variables put together and students' performance in chemistry the study recommended that: the working memory demands of classroom activities can be reduced by minimizing processing requirements. This can involve simplifying the language used in tests of problem solving, reducing the use of technical language, and increasing the meaningfulness and degree of familiarity of material to be processed; and that he storage demands of classroom tasks can be reduced by restructuring multiple step tasks into separate independent steps, using external memory aids, and frequently repeating important information among others.*

Keyword: *Effect, Short term Memory & Reading Comprehension on students' Performance in Chemistry*

Introduction

The amount of immediate recall of visual stimuli depends upon the two mechanisms of attention and memory. The studies of Peterson and Peterson (1959), Murdock (1962, 1963), Melton (1963), and of Kintz (1965) show that as time between stimulation and recall increases, the amount recalled rapidly decreases. Schneider and Kintz (1967) showed that instructions which directed attention to various stimulus characteristics affected control over the amount of material recalled on an incidental learning task: The more direct the attention, the better the recall. Short-term memory is the ability to apprehend and hold information in immediate awareness and then use it within a few seconds. It is the ability to hold information in one's mind and then use it within a few seconds. Working memory, a subcomponent of short-term memory, includes the ability to attend to and immediately recall temporally ordered elements in corrected order after a single presentation, as well as the ability to store temporarily and perform a set of cognitive operations on information that requires divided attention. Working memory relates to an individual's ability to attend to verbally- or visually-presented information, to process information in memory, and then to formulate a response. Difficulties with working memory may make the processing of complex information more time-consuming, draining a student's mental energies more quickly and perhaps result in more frequent errors on a variety of tasks. Short-term memory is important to reading achievement. Reading comprehension, involving long reading passages, may be affected by skills specifically related to working memory. Basic word reading may be impacted by deficits in short-term memory because it may interfere with acquiring letter and word identification skills.

Short-term memory is important to math computation skills. For example, deficits in short-term memory may impact one's ability to remember a sequence of orally presented steps required to solve long math problems (i.e., first multiply, then add, then subtract).Short-term memory is important to writing. Memory span is especially important to spelling skills, where working memory has shown relations with advanced writing skills (e.g., written expression).A student with short-term memory deficits may have problems

following oral directions because they are unable to retain the information long enough to be acted upon. A student with short-term memory deficits also may have problems with oral expression because of difficulties with word-find or being unable to retain information long enough to verbally express it. Studies, requires them to be able to read at increasingly higher levels. For example, in second grade the mathematics portion of the STAR test in California is read orally to all of the students, but at higher grade levels only the initial instructions are read aloud.

Students in higher grade levels are responsible for reading and comprehending all of the directions, passages, and other printed information within the test. California schools are evaluated based on student performance on these standardized tests and approximately forty percent of students going to public school are attending schools undergoing "program improvement" for failing to achieve the goals of No Child Left Behind (Crane, Huang, Derby, Makkonen, &Goel, 2008). Students not performing well on their tests could be because they are struggling to read and comprehend the test questions that they are being confronted with. Students need practice reading in order to develop their phonemic awareness, phonics, fluency, vocabulary, and comprehension. The mastery of these skills will grant them access to increasingly complex knowledge in other academic subject areas.

Short Term Memory

Working memory used to be called short-term memory. It was redefined to focus on its functionality rather than its duration. Some cognitive psychologists, however, differentiate between working and short term memory. They see short-term memory as involved with the brief storage of information, while working memory is involved with both storing and manipulating information. Working memory can be thought of as the equivalent of being mentally online. It refers to the temporary workspace where we manipulate and process information. No one physical location in the brain appears to be responsible for creating the capacity of working memory. But several parts of the brain seem to contribute to this cognitive structure (Goldstein, 2010). Working memory is characterized by a small capacity. It can hold around four

elements of new information at one time. Because learning experiences typically involve new information, the capacity of working memory makes it difficult to assimilate more than around four bits of information simultaneously. The capacity of working memory depends on the category of the elements or chunks as well as their features. For example, we can hold more digits in working memory than letters and more short words than long words. The limitations on working memory disappear when working with information from long-term memory (permanent storage) because that information is organized into schemata. Schemata are higher order structures made up of multiple elements that help to reduce the overload on working memory (Gog et.al, 2005).Working memory is the ability to hold information in head and manipulate it mentally. We use this mental workspace when adding up two numbers spoken to us by someone else without being able to use pen and paper or a calculator. Children at school need this memory on a daily basis for a variety of tasks such as following teachers' instructions or remembering sentences they have been asked to write down (Alloway, 2010).

Working memory is a tool used by everyone to help us perform efficiently and effectively in all aspects of our lives. This essential tool is defined as the ability to maintain and manipulate information in the mind for a brief period of time, often termed, "short-term memory" (Beer, et.al, 2010). Working memory is responsible for temporarily maintaining and manipulating information during cognitive activity (Baddeley, 2002). It has been found to be closely related to a wide range of high-level cognitive abilities such as reasoning, problem-solving, and learning. In addition, WM is related to academic achievement in the domain of reading, writing (Abu-Rabia, 2000).

The working memory demands of classroom activities can be reduced by minimizing processing requirements. This can involve simplifying the language used in tests of problem solving, reducing the use of technical language, and increasing the meaningfulness and degree of familiarity of material to be processed. The storage demands of classroom tasks can be reduced by restructuring multiple step tasks into separate independent steps, using external memory aids, and frequently repeating important information

(Gathercole&Alloway, 2004). Executive or processing efficiency could be improved via training of planning and meta-cognitive strategies (Yvisaker&Debonis, 2000), or by repeated practice on working memory and intentional tasks. A final approach would be to teach participants to use memory strategies that allow them to use working memory more efficiently. For example, using rehearsal, visual imagery, or semantic strategies can improve memory performance. This in turn may assist in remembering task relevant information and improve performance on cognitive tasks. Training participant to use memory strategies can improve performance on both measures of working memory and complex tasks such as remembering and following instructions in the classroom.

Reading Comprehension

The Penguin Dictionary of Psychology (Preber 1995; 638) defines reading as —...the process by which information is extracted from written or printed text. 'It continues to say that the process is extremely complex and is dependent on two critical aspects that is:

i)The written format of the words and the readers ability to decode the phonetic relationship between the letters on the page and the sounds of the spoken language and

ii) Semantic/syntactic process that has to do with the meaning of the words which are being pronounced.

Seyler (1997) defines reading as a process of obtaining or constructing meaning from a word or cluster of words. Reading means understanding the ideas or information of the words put together in a particular pattern chosen by the writer. If we are not getting meaning then we are not reading. It is a cognitive activity. You read with your brain.

In the state of Florida, roughly twenty percent of students are receiving reading intervention. Interventions in Kindergarten focuses on phonological awareness, phonics, and word recognition and are usually taught by a paraprofessional in the classroom, while interventions in third grade focuses on engaging students for longer periods of time with lengthier texts involving more complex skills

and are taught by specialized reading intervention teachers (Wanzek& Cavanaugh, 2010). The shift from intervention being offered by a paraprofessional to a reading intervention teacher may be because students' reading scores at the second-grade and third-grade levels consistently grow more rapidly than their peers when they are engaged in high-level thinking about the texts that they read (Peterson & Taylor, 2012).

In another study which examined English language learners fluency and comprehension, over half of the students assessed had a significant gap between their reading fluency and comprehension scores and found that fluency increased at a greater rate than reading comprehension (Quirk &Beem, 2012). On average, roughly 15% of students in grades two and three are word callers, which means that they decode words and can say them, but they do not know the meaning of the words. This demonstrates the risk that textbooks pose to students who are learning English or who have strong decoding skills combined with a limited vocabulary because they may be decoding the words, but they may not be correctly interpreting them. This is the truest of EL students at the intermediate proficiency level (Quirk &Beem, 2012). One method to scaffold for those EL students is to provide them with cognate instruction in order to connect root words in English to root words in their native language when they share historical roots (Goodwin, Lipsky, &Ahn, 2012).

Reading is a psycholinguistic process in that it starts with a linguistic surface representation encoded by a writer and ends with the meaning which the readers construct. There is an essential interaction between language and thought. Brielby (1999) observes that reading means the way we make sense of print translating black marks on the page into meaning. Reading is a means of learning a language, of communicating and of sharing information and ideas. It is a complex interaction between the text and the reader which is shaped by the reader's prior knowledge, experiences, attitude and the reader's language community which is culturally and socially situated. The reading process requires continuous practices, development and refinement. Walter (1982) refers to reading as an active thinking process of identifying important ideas, comparing, evaluating and applying them. Clarke (1988) suggests that language

problems seem to be the most frequent source of reading difficulties to ESL learners which leads to lack of comprehension. Grellent (1981) observes that for students to read efficiently they must adapt their reading speed and techniques to their aim of reading. Fluent reading must occur rapidly in almost any purposeful context, and the more rapidly a text is read, the better the various processing components are likely to operate. Reading is an interactive process. Widdowson(1997) has discussed reading in this light as the process of combining textual information with the information the reader brings to the text. In this view, reading process is not simply a matter of extracting information from the text. Rather, it is the one in which reading activates a range of knowledge in the readers mind that he or she uses and that in turn may be refined and extended by the new information supplied by the text. Reading is thus viewed as a kind of dialogue between the reader and the text. The process of reading consists of two main components which are word recognition or decoding and reading comprehension.

Readers skilled in decoding comprehend text better than the poor decoders. Children who are good decoders read more words than the poor ones (Joel, 1988) which leads to greater reading growth. Cornoldi and Oakhill (1996) note that decoding and comprehension are correlated. Skilled reading clearly requires skill in both decoding and comprehension. Comprehension is what reading is all about. It is meaning gained from reading. Anderson et al (1997; 369) observes that every act of comprehension involves ones knowledge of the word as well. Comprehending a text is an interactive process between the reader's background knowledge and the text. Efficient comprehension requires the ability to relate textual material to one's knowledge. Comprehending words, sentences and entire text involves more than just relying on one's linguistic knowledge. What we remember of a text is not wording of the text itself but the meaning we make of it including the inferences we have made in a single integrated whole.

Machet and Pretorius (2003) point out the different skills and knowledge that a reader needs so as to develop reading comprehension. The skills include the ability to link information in a text, the ability to use background knowledge, the ability to read in between the lines and make connections between the

things described in a text, the ability to differentiate between main ideas and those that are of secondary importance, ability to make predictions about what is being read and ability to draw conclusions about what has been read. Pretorius (2000) notes that —students need to be good at reading to be able to read to learn. In her research amongst undergraduate students in UNISA, the findings showed evidence for difference in reading ability in relation to academic performance.

Experts estimate one needs to understand at least 90% of words in a passage to infer the meaning of the other 10%. When word knowledge falls below 90% in a given passage, comprehension falls greatly. Interestingly, 90% of the reading difficulties of adolescents are due to problems with comprehension, only about 10% are due to accuracy, decoding, or word level difficulties (e.g. dyslexia). Many of our students just do not have enough broad academic background knowledge in social studies, science, and other content areas to read well, and formal comprehension skills can only take them so far. Content knowledge, and vocabulary acquired through learning about content, is what enables comprehension ability to increase. In fact, no amount of reading "comprehension skills" instruction can compensate for lack of knowledge.

The Effects of Short Term Memory and Reading Comprehension on Students' Performance in Science and Math

The relationship between reading ability and academic performance seems like a logical connection since textual information is prevalent in our society. Espin and Deno (1993) found that a relationship exists between basic reading literacy and student academic success. Their study involved 121 tenth-grade students in a rural school in a small mid-western community. Their study was based on the connection between a student's reading measure and that student's score from a classroom study task, grade point average, and achievement test results. Another recent study focusing on secondary students was conducted by Cromley (2009). This study focused specifically on reading and proficiency in science with an international perspective and included several countries, including the United States. He found that there was a very high correlation between reading comprehension and science proficiency, with the mean for all

of the nations being .819. The United States was among the nations with the highest correlation between reading and science. Cromley(2009) noted that the 2006 tests used in this study to measure science achievement, the Programme on International Student Assessment (PISA), was designed to require less reading, which emphasizes the high correlation between reading and science achievement.

Mathematics is another subject area in which performance can be linked to reading ability. A study conducted by Vilenius-Tuohimaa, Aunola, and Nurmia (2008) looked at the relationship between students' ability to solve math word problems and students' text comprehension skills. Their study included 225 fourth grade students and found that the better a student's reading comprehension skills, the better his or her performance on mathematical word problems. In addition to the correlation between reading comprehension and word problem solving, the study also found that both of those skills were related to technical reading. Although their results showed that technical reading ability could predict a higher skill level at reading comprehension and math problem solving, when they controlled for technical reading, the covariance between word problem solving and reading comprehension was still present. The authors explain that a reader with poor decoding skills struggles with the text itself and isn't able to perform the tasks requiring logical reasoning strategies. It is a reasonable explanation that a student who struggles to decode text is going to perform poorly in all subject areas because there are more hindrances in comprehending text. There are several components to reading which can impact mathematical performance.

A study conducted by Grimm (2008) examined the relationship between early reading skills and growth in math skills. His study examined third grade students and found that students who had a higher level of reading comprehension tended to learn problem solving and data interpretation skills faster than those with weaker reading comprehension. Interestingly, student computational skills were unaffected by early reading comprehension, which indicates that reading comprehension is linked to a more conceptual understanding of math (Grimm, 2008). A study with a focus on reading comprehension explicitly related to

math was conducted in Turkey by Duru and Koklu (2011). The authors looked at middle school students' ability to read a mathematical text and convert it into an algebraic equation and vice-versa. The data from the study indicated that students had low reading comprehension which prevented them from comprehending the mathematical texts and algebraic equations representing those texts. The authors believed that there were several factors involved, such as students' inability to organize prior knowledge and their lack of knowledge about the meaning of symbols, signs, and words used in mathematics (Duru&Koklu, 2011). The study indicates that vocabulary is an important component of reading which supports comprehension.

Research into working memory measures a student's capacity to acquire knowledge rather than measuring what the student has already learned (Alloway, 2011). This is important because it can predict outcomes independently from the student's IQ (Alloway, 2011). There is considerable anecdotal evidence that passing examinations in science is not the same as understanding the subject. At the university level, for example, Haghanikar (2003) reported in Alloway (2011) tested the understanding of students who had recently passed an examination in positional astronomy by presenting them with a series of simple tasks necessary for finding one's location on Earth (as when shipwrecked on a desert island). Their performance was poor, showing that, while they were comfortable with the use of the formulae and co-ordinate systems of spherical astronomy, they had little understanding of how these were related to observations of the Sun and stars. On the other hand, some areas of science subjects are notoriously fragile. Special relativity is one such. It is often observed that one year's class cannot do the problems set by last year's lecturer despite the complete identity of the material taught. Evidently, the students' understanding is poorly developed and even small differences in problem style or presentation can cause trouble. Understanding is not easy to define. It seems to have rather different meanings in different contexts. In science, at least, though, to understand something normally means that you can see how to answer any question you may be asked (which is not the same as actually answering it), regardless of the direction from which it comes. When confronted with a question that you cannot see how to tackle, your

understanding has been challenged. However, this is not merely a didactic issue. Science itself progresses by uncovering gaps in understanding through the asking of challenging questions.

Research in science education has referred to limitations in information processing resulting from both mental capacity and working memory capacity. Mental capacity is often conceptualized within the framework of the theory of constructive operators. However, the cognitive resources underlying working memory are not well specified within the context of science education. Research demonstrates that individual differences in working memory capacity may account for differences in performance of information processing tasks, like reading and note-taking. In studies with children, those who have a poor ability to store material over brief periods of time (difficulties with working memory) fail to progress normally in tasks related to literacy. An individual's developmental age and level of expertise probably account for differences in working memory. For example, facilitating learning can be helpful for novices but detrimental to experts.

Statement of Problem

It is important to understand the correlation between short term memory, and reading comprehension on academic performance in chemistry and to determine where the correlation is strong enough to consider utilizing a reading intervention program as the primary intervention for low student performance in other academic areas. For this study, reading performance includes comprehension, spellings and vocabulary abilities. Academic performance encompasses students' performance on summative assessments in chemistry. In most chemistry coursework, students are required to read and interpret written equations, graphs, and other documents, which have similar properties to text. For example, students read text left to right and chemistry equations are also read left to right. Additionally, students are expected to read and interpret chemistry equations in order to solve them, which is a similar process to reading and interpreting text in math.

Objectives of the Study

The purpose of this study is to extend the current research linking reading performance to academic performance by examining the relationship between reading and performance in chemistry at the senior secondary (SS) I and II levels.

Research Questions

1. What is the strength of correlation between performance in reading comprehension, digit span, short term memory, spelling and vocabulary and chemistry performance at the SSI and SSII levels?
2. Does short term memory, digit span, reading comprehension, spelling and vocabulary affect the performance of students in chemistry SSI and SSII levels?

Hypothesis

There is no significant relationship between chemistry students' short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) and their performance in chemistry.

Significance of the Study

The extent of correlation between short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) will be established. The results of the findings will be of importance to the Borno State Ministry of Education, principals, teachers, parents and students alike. This will help the stake holders consider introducing reading help to the students if there happens to be areas of deficit.

Scope of the Study

The study covered chemistry SS1 and SS2 chemistry students of a selected secondary school in Maiduguri. The study was delimited to short term memory (recall and digit span), reading performance (comprehension, spelling and vocabulary) in relation to the students' performance in chemistry.

Methodology

Research Design

The design of the study is correlational to establish the effects of short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) on students' performance in chemistry. The design was chosen because it has the ability to establish level of significance and magnitude of relationship.

Population and Sample

The participants for this study come from a secondary school in Northern Nigeria, selected purposefully because the researcher is employed there. The school offers secondary education from the junior secondary school one level through to senior secondary school three level. It is a small school with a student population of approximately 250. There is a class of science students in each of the arms of SSS1- SSS3 in the school which have a population of 143 students in the three classes. Nearly three-fourths of the students come from socioeconomically disadvantaged backgrounds and over a third are English language learners. All science students at each of the SSS levels are assessed in chemistry as part of their traditional schooling. The reading assessment selected for this study were designed to accurately assess SSS1 and older students. Since several studies have already shown that reading impacts academic performance in math and science at the secondary level, data was collected and analyzed from the entire SSS1and SSS2 science student population at the school site. This focused the study on the senior secondary science grade levels that the assessments were designed to test and excluded the population of senior secondary Arts students and junior secondary students in the school. The SSS3 science students were exempted from the study because at the time of this study, they were writing their school leaving certificate examinations. A total of 78 students were examined. The student population included 28 SSS2 and 50 SSS1.

Research Instrument

Data on students' performance in chemistry was obtained from the school's students' record books. Students were given benchmark exams over the course of the year from their chemistry program. The mean score for the first two

cumulative tests for each student were used to determine the average performance level of each student. Some students, who transferred to the school during the year and did not have two cumulative tests on record, had their average performance based on all available cumulative tests from this school year. These tests were administered by the individual classroom teachers, as part of the curriculum, over the course of the year in the classrooms where students received instruction.

The data on student performance on short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) was also obtained from a self-constructed test administered to the chemistry students by the researcher. The three parts of reading ability that were assessed were spelling, vocabulary, and comprehension, with each student receiving a composite overall score. The assessment was conducted in the researcher's classroom during the month of May, 2016.

Method of Data Analysis

After the data was collected, each student's performance in short term memory (recall and digit span) and reading (comprehension, spelling, and vocabulary) as well as chemistry performance were entered into a spreadsheet of composite scores. Then the data was processed by a web-based statistical software package to determine if a relationship exists. The statistical tool employed was Multiple Regression to determine the relationship between these four variables and chemistry performance at the SS1 and SS2 levels.

Data Analyses and Results

HO_1: There is no significant relationship between short term memory (recall and digit span), reading comprehension, spelling and vocabulary chemistry performance of SS1 and SS2 chemistry students.

Table 1a: Inter Item Analysis of the Effect of Short Term Memory (recall and digit span) and Reading (Comprehension, Spelling and Vocabulary) on Students' Performance in Chemistry

Model	R	R^2	F	p – value	Remark
Digit span	0.464	0.000	3.003	0.959	NS
Recall	0.333	0.111	8.252	0.020	S
Comprehension	0.444	0.197	6.936	0.002	S
Vocabulary	0.444	0.197	2.027	0.006	S
Spelling	0.444	0.197	2.013	0.015	S

Table 1a shows the inter–relationship between the variables of short term memory and the variables of reading against chemistry performance. The result displays a model of individual variables and their effects on the constant factor. From the result, the first test between digit span and chemistry performance r2 = 0.464 = 46.4%, which is the percentage of the effect of the dependent factor on the independent variable and at $F_{(3,4)}$ = 3.003 there was a p – value of 0.959 which was recorded to be not significant when compared with p<0.05. The second, third, fourth and fifth test between recall, comprehension, vocabulary and spelling with the factor variable (chemistry performance), r^2 = 0.333 = 33.3%, r^2 = 0.444 = 44.4%, r2 = 0.444 = 44.4% and r^2 = 0.444 = 44.4% with p < 0.020, 0.002, 0.006 and 0.015 respectively. This in general has revealed that there is a significant effect of the four variables (digit span, recall, comprehension &vocabulary) on students' performance in chemistry. This implies that the null hypothesis is rejected, and the alternate accepted.

Table 1b: Combined effect of Short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) on students' performance in chemistry

Model	R	R^2	F	p – value	Remark
	0.392	0.614	2.292	0.056	S

Table 1b shows a combined effect of the five variables against chemistry performance. The result displays a model summary of the combined variables and their effects on the constant factor. From the result, there was r^2 = 0.614 =

61.4%, which is the percentage of the effect of the dependent factor on the independent variables and at $F_{(2, 2)} = 2.292$ there was a p – value of 0.056 which was recorded to be significant when compared with $p<0.05$. This in general has revealed that there is a significant effect of all the variables when compared with students' results obtained in chemistry. Therefore the null hypothesis is rejected and the alternate hypothesis accepted.

Summary of Findings

The results of the analysis of this study revealed that:

1 there is significant relationship between recall and students' performance in chemistry
2 there is significant relationship between digit span and students' performance in chemistry
3 there is significant relationship between comprehension and students' performance in chemistry
4 there is no significant relationship between spelling and students' performance in chemistry
5 there is significant relationship between vocabulary ability and students' performance in chemistry
6 there is significant relationship between all the five variables put together and students' performance in chemistry

Discussion

The test of hypothesis on relationship of the performance of students in short term memory (recall and digit span) and their performance in chemistry revealed that there is significant relationship. This is an important requirement for Children at school who need this memory on a daily basis for a variety of tasks such as following teachers' instructions or remembering sentences they have been asked to write down (Alloway, 2010).

The test of the relationship between reading (comprehension, spelling and vocabulary) and students' performance in chemistry revealed significant relationship between comprehension and students' performance in chemistry. This is in agreement with Espin and Deno (1993) who found that a relationship

exists between basic reading literacy and student academic success. The study revealed there is no significant relationship between spelling and their performance in chemistry.

Conclusion

The findings of this study are in agreement with the assumption that reading comprehension is related to academic performance at the secondary level. Short term memory is related to academic achievement in the domain of reading, the relationship between reading ability and academic performance seems a logical connection since textual information is prevalent in our society a relationship exists between basic reading literacy and student academic success.

Recommendation

Since the findings of the study revealed that there is a relationship between short term memory, reading and students' performance in chemistry,

1 The working memory demands of classroom activities can be reduced by minimizing processing requirements. This can involve simplifying the language used in tests of problem solving, reducing the use of technical language, and increasing the meaningfulness and degree of familiarity of material to be processed.

2 The storage demands of classroom tasks can be reduced by restructuring multiple step tasks into separate independent steps, using external memory aids, and frequently repeating important information.

3 Executive or processing efficiency could be improved via training of planning and meta-cognitive strategies, or by repeated practice on working memory and intentional tasks.

4 Teachers should point out the different skills and knowledge that a reader needs so as to develop reading comprehension. The skills include the ability to link information in a text, the ability to use background knowledge, the ability to read in between the lines and make connections between the things described in a text, the ability to differentiate between main ideas and those that are of secondary importance, ability to make predictions about what is being read and ability to draw conclusions about what has been read should be taught.

5 For students to read efficiently, they must be taught to adapt their reading speed and techniques to their aim of reading.

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Reference to this paper should be made as follows: Rhoda E. Camble (2016), The Effects of Short Term Memory and Reading Comprehension on Students' Performance in Chemistry in Jere, Borno State, Nigeria. *J. of Education and Policy Review,* Vol. 8, No. 2, Pp. 1 – 20.