RELATIONSHIP AMONG SHORT TERM MEMORY, READING COMPREHENSION AND PERFORMANCE IN CHEMISTRY AMONG SENIOR SECONDARY SCHOOL STUDENTS IN UNIMAID DEMONSTRATION SECONDARY SCHOOL, MAIDUGURI, NIGERIA

CAMBLE, RHODA EMMANUEL;

ABUBAKAR, HAMMAN-TUKUR

&

BUKAR, AISHA
Department of Education, University of Maiduguri, Nigeria

Abstract
The study examined the relationship among short-term memory, reading comprehension and academic performance in chemistry among senior secondary school students in Unimaid Demonstration Secondary School, Maiduguri. Gender and class differences in performance on short term memory test, reading comprehension test and students' performance in chemistry were also investigated. The design of the study was correlation. The result revealed that there is a significant gender and class difference in short term memory, reading comprehension and academic performance in chemistry. The analysis on the relationship between short-term memory, reading comprehension and academic performance in chemistry revealed significant relationship at a p – value of 0.056. The study recommends that reading programme be introduced in schools to enhance better academic performance of students in chemistry and to include exercises that will improve students' short term memory in the curriculum.

Keywords: *Short term memory, Reading comprehension, Gender, Performance relationship*

Introduction

Students are the key assets of secondary schools. The students' performance plays an important role in producing best quality graduates who will become great leaders and manpower for the country thus responsible for the country's economic and social development. Academic achievement is one of the major factors considered by higher institutions of learning for the purpose of admission and placement. Thus, students have to put the greatest effort in their study to obtain good grades and to prepare themselves for future opportunities in their career at the same time to fulfill admission demand.

Success in school requires many skills. For example, for children to navigate school settings effectively they need to be able to focus their attention on their teacher, complete tasks in the context of many distractions, and inhibit impulsive thinking and behavior. They also need to remember instructions and be able to complete tasks without forgetting critical information (Stipek and Valentino, 2010). The

importance of these attention and memory skills for academic success is supported by theories and research evidence. Many theorists have noted that both short-term and working memory is required for the complex cognitive operations involved in learning school subjects such as mathematics and reading, and in the last decade there has been proliferation of studies demonstrating that several different facets of memory predict academic skills (Raghubar, Barnes & Hecht, 2010; Savage, Lavers, & Pillay, 2007). In addition, extant studies have shown significant associations between children's ability to regulate their attention and their academic performance (e.g., Duncan et al., 2007; Kos, Richdale, & Hay, 2006).

It has been a long belief that women have better multi-tasking skills than men. Multi-tasking involves doing several tasks at once, which would involve the use of short term memory. If women are better at multi-tasking than men, it would seem that they would have better short term memory as well (Knox, Bergstein, Seth, Long & McElveen, 2009). Does gender affect short term memory? The debate over whether there is any difference between men and women when it comes to our brains has raged for some time. While there are similarities, science has been uncovering some real differences as well but the question is "do those difference apply to memory"?

Short-term memory is the ability to apprehend and retain information in immediate awareness and then use it within a few seconds (Crane, Huang, Derby, Makkonen, & Goel, 2008). It is important to reading achievement. The ability to write, read, spell and identify signs, letters and words lie greatly on the memory's ability to recall previous texts, words, letters or instructions. 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 (Crane, Huang, Derby, Makkonen, & Goel, 2008). The cognitive mechanisms underlying acquisition of reading ability have been studied extensively over the past decades (Daneman et al., 1980) and the complexity of its nature is well-demonstrated (Carretti et al., 2009; Kudo et al., 2015). Becoming reading proficient requires a delicate interplay between different cognitive abilities along with formal instruction and practice. The Penguin Dictionary of Psychology (Preber 1995; 638) defines reading as the process by which information is extracted from written or printed text. Reading is a process of obtaining or constructing meaning from a word or cluster of words; thusit means understanding the ideas or information of the words put together in a particular pattern chosen by the writer. Comprehension is what reading is all about. It is meaning gained from reading. Pretorius (2000) in Cromley (2009) notes that students need to be good at reading to be able to read to learn an evidence for difference in reading ability in relation to academic performance; basic word reading may also be impacted by deficits in short-term memory because it may interfere with acquiring letter and word identification

skills. As reading proficiency involves both cognitive abilities and skill acquisition, the strength of the relation between STM and reading is likely to vary over time depending on both cognitive maturity and skill development.

Performance is defined as the observable or measurable behaviour of a person or an animal in a particular situation usually experimental situation (Simpson and Weiner, 1989). This means that performance measures the aspect of behaviour that can be observed at specific period. To determine performance, a performance test is conducted. Performance test as the type of mental test in which the subject is asked to do something rather than to say something. Performance test is the type of test which elicits on the ability of a student to deal with things rather than symbols.

Although women have been shown to outperform men on semantic tasks like verbal fluency and synonymgeneration (e.g., Herlitz et al., 1999; Kimura & Harshman, 1984; Loonstra, Tarlow, & Sellers, 2001; Larsson, Lovden, & Nilsson, 2003; Maitland, et al., 2004), the presence of gender differences on linguistic tasks is not a uniform finding (see Halpern, 2000; Kimura, 1999 for reviews). For instance, there have been reports of men outperforming women on linguistic tasks such as the verbal SAT (e.g., Jackson & Rushton, 2006) and verbal intelligence tests (e.g., Quereshi, 1994). Similarly, there have been suggestions that effects of gender on verbal learning tasks become non-significant once age and education levels are taken into account (e.g., Ryan, Kreiner, & Tree, 2008). Moreover, the mechanisms underlying the gender differences on verbal tasks (when they are obtained) are not at all clear, since there is currently no accepted theoretical framework for examining and explaining gender differences in linguistic performance. In the present study, we examine whether gender differences are present on a word-learning task, and test one account of how gender influences linguistic performance – the Declarative/ Procedural Model. This model, proposed by Ullman and colleagues (2001; 2004; 2005; 2008) localizes the female advantage on linguistic tasks to the declarative memory system, however, gender differences in memory performance have seldom been examined explicitly (Herlitz, Nilsson, & Backman, 1997).

In a 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 and Beem, 2012). 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. Widdowson (1997) has discussed reading as the process of combining textual information with the information the reader brings to the text. It is the one in which reading activates a

range of learning skills leading to the path of knowledge in the reader's mind that he or she uses which 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.

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 nation's being .819. The United States was among the nations with the highest correlation between reading and science. Mathematics is another subject area in which performance can be linked to reading ability. A study conducted by Vilenius-Tuohimaa, Aunola, and Nurmia (2008) studied 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. 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, students' 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 examined 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.

Statement of the Problem

Studies linking performance on memory tasks to performance on academic tasks focus mostly on working memory, in some cases using short-term memory as a covariate, but studies have also shown associations between academic skills and short-term memory. The present study therefore casts a wide net by including measures of both short-term memory and reading comprehension employing in each case verbal and numeric task. It also looked at gender differences in performance on short term memory test, reading comprehension test and students' performance in chemistry. The students' ability to recall instructions and sequences (short term memory) is required to enhance students' performances. 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. Also, literature reviewed revealed a relationship between immediate recall and academic performance of students. Does this apply to Senior Secondary School chemistry students in University of Maiduguri (Unimaid) Demonstration Secondary School? What is the relationship between senior secondary school students' short term memory, reading comprehension and academic performance in chemistry? Is gender and class placement responsible for difference in the performance of the students?

Objectives of the Study

The objectives of the study are to:

1 Examine the gender difference in performance on short term memory and reading comprehension.
2 Examine the impact of class on short term memory and reading comprehension.
3 Examine the relationship between short term memory, reading comprehension and students' academic performance in chemistry.

Hypotheses

1 There is no gender difference on short term memory, reading comprehension and academic performance among senior secondary chemistry students of Unimaid Demonstration Secondary School.
2 Class has no significant impact on short term memory, reading comprehension and academic performance among senior secondary chemistry students of Unimaid Demonstration Secondary School.
3 There is no significant relationship between short term memory, reading comprehension and academic performance of chemistry students of Unimaid Demonstration Secondary School.

Methodology

The design of the study was correlational, while the purpose was to determine the relationship between short term memory, reading and students' academic performance in chemistry. Also regression analysis was used to establish relationship pattern. The population of the study was students of University of Maiduguri Demonstration secondary school in Maiduguri, Borno State, Nigeria. The sample comprised 78 SS1 and SS2 chemistry students of the school. The items in the reading assessment were subjected to validation by content experts that vetted to check for appropriateness and relevance. The reading assessments selected for this study were designed to cover comprehension, vocabulary and spelling. A passage was selected from the students' chemistry text. Five questions tested their comprehension, five tested their word knowledge (vocabulary) and they were to spell ten words from the passage. A set of three numbers (starting from two digits and ending at five digits) were read to the students. They were to write it as it was read out to them. On recall, sets of words (from two letter words to six letter words) were read out in a particular sequence. The students were to rewrite them down.

Data on students' performance in chemistry were obtained from the school's students' records. 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 the students' short term memory (recall and digit span) and reading (comprehension, spelling and vocabulary) were also obtained from a self-constructed reading assessment test administered to the chemistry students by the researchers; each test was scored over 100. The three parts of reading ability that were assessed were spelling, vocabulary, and comprehension, with each student receiving a composite overall score.

Results

The data obtained for this study was subjected to data analysis using SPSS version 20. The independent sample test was used to analyze hypothesis I and II, while regression analysis was used in testing hypothesis III. The results of the analysis are presented in tables 1, 2 and 3 respectively.

Ho_1: There is no gender difference on short term memory, reading comprehension and academic performance among senior secondary chemistry students of Unimaid Demonstration Secondary School.

Table 1: Result of t- test on Difference Based on Gender on short term memory, reading comprehension and academic performance

N = 69: Male = 40, Female = 29					
Variables	**Gender**	**Mean**	**Std. Deviation**	**t**	**Sig.**
Digit Span	Male	91.6897	11.82039	.051	.036
	Female	91.5500	10.66494	.050	
Recall	Male	78.1379	15.07771	2.869	.006
	Female	65.5750	19.76255	2.994	
Comprehension	Male	80.7586	22.63161	2.193	.004
	Female	68.6750	22.56999	2.192	
Vocabulary	Male	35.0000	31.25471	.311	.032
	Female	32.9250	24.18241	.299	
Spelling	Male	78.6552	19.33405	1.735	.887
	Female	70.5000	19.23538	1.733	
Chemistry Result	Male	68.5517	14.57146	3.516	.001
	Female	56.0250	14.63310	3.519	

Table 1 provides information on the differences between male and female with regards to short term memory, reading comprehension and academic performance. The result revealed that there was a significant difference between male and female in digital span, recall, comprehension, vocabulary and overall academic performance in chemistry in Unimaid Demonstration secondary school, Maiduguri. Statistics shows a $p<0.036$, 0.006, 0.004, 0.032 and 0.001 for the respective variables responsible for short term memory. Hence since all five out of the six variable have shown significant difference, it implies that the null hypothesis is hereby rejected, and the null hypothesis accepted, which indicates that there is a gender difference in performance on short term memory, reading comprehension and academic performance in Chemistry among senior secondary chemistry students at various academic in Jere.

Ho_1: Class has no significant impact on short term memory, reading comprehension and academic performance among senior secondary chemistry students of Unimaid Demonstration Secondary School.

Table 2: Result of t- test on difference Based on Class in short term memory, Reading comprehension and Academic performance

N = 69: Male = 40, Female = 29					
Variables	**Class**	**Mean**	**Std. Deviation**	**t**	**Sig.**
Digit Span	Senior Secondary I	92.1111	10.22942	.300	.048
	Senior Secondary II	91.2857	11.70425	.309	
Recall	Senior Secondary I	57.4815	20.71672	-5.707	.001
	Senior Secondary II	79.4524	11.21672	-5.055	
Comprehension	Senior Secondary I	77.8148	16.96385	1.168	.033
	Senior Secondary II	71.1429	26.34163	1.280	
Vocabulary	Senior Secondary I	35.3704	31.85804	.383	.013
	Senior Secondary II	32.7857	24.05941	.361	
Spelling	Senior Secondary I	71.4074	20.36637	-.856	.425
	Senior Secondary II	75.5476	19.09438	-.844	
Chemistry Result	Senior Secondary I	58.8519	14.49590	-1.029	.023
	Senior Secondary II	62.8571	16.53315		

Table 2 contains information on the differences between senior secondary one (SS I) and Senior Secondary two (SS II) with regards to short term memory, reading comprehension and academic performance. The result revealed that there is a significant difference between SS I and SS II in digital span, recall, comprehension, vocabulary and overall academic performance in chemistry, except for spelling. The statistics showed a $p<0.048$, 0.001, 0.013, 0.032 and 0.023 for the respective variables responsible for short term memory and reading comprehension. Since all five out of the six variables have shown significant difference, it implies that the null hypothesis is rejected, and the alternate hypothesis accepted, thus, Class has a significant impact on short term memory, reading comprehension and academic performance among senior secondary chemistry students of UDSS, Maiduguri at various academic levels.

Ho3: There is no significant relationship between short term memory, reading comprehension and academic performance among senior secondary chemistry students of University of Maiduguri Demonstration Secondary School.

Table 3: Results of Relationship among Short term memory, reading comprehension and performance in chemistry of SSI and SSII students

Model	**R**	**R^2**	**F**	**SIG**
	0.912	0.514	2.292	0.056

Table 3 shows the regression analysis of relationship between short term memory and reading comprehension on the constant factor academic performance. From the result, there was $r^2 = 0.514 =$ 51.4%, which is the percentage of the effect of the dependent factor on the independent variable 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 revealed that there is a significant relationship among the variables (digital span, recall, comprehension, vocabulary and spelling) combined when compared with students results obtained in chemistry. This implies that the null hypothesis is rejected and the alternate accepted.

Discussion

The t-test on gender difference in students' short term memory, reading comprehension and academic performance revealed significant differences which imply that gender has effect on the students' performances. Same is applicable to the effect of class on the students' performances in short term memory; reading comprehension and academic performance. The t-test of the difference based on class between short term memory, reading comprehension and students' performance in chemistry revealed significant difference. The regression analysis of the relationship between short term memory, reading comprehension and academic performance in chemistry revealed significant relationship.

Conclusion

From the findings of this study, there is difference in relationship based on gender and class among short term memory, reading comprehension and academic performance in chemistry. Short term memory, reading comprehension and academic performance in chemistryare positively related. Therefore, students need to have good short term memory to be able to recall instructions and make meaning out of textual material. The possession of good short term memory and appreciable reading ability will greatly enhance excellent academic performance in chemistry.

Implication for practice

By implication, a student with short-term memory deficits may have problems with oral expression because of difficulties with word-find or being unable to retain information long enough to verbally express it. Consequently, an important requirement for Children at school in addition to reading is short term memory which is needed on a daily basis for a variety of tasks such as following teachers' instructions or remembering sentences they have been asked to write down.

Recommendations

1 Reading programme should be introduced in schools by chemistry teachers to enhance excellent academic performance in chemistry.

2 Curriculum reviewer should include activities that improve short term memory of students for better academic performance.

References

Albus, M., Hubmann, W., Mohr, F., Scherer, J., Sobizack, N., Franz, U., Hecht, S., Borrmann, M., & Wahlheim, C. (1997). Are there gender differences in neuropsychological performance in patients with first-episode schizophrenia? *Schizophrenia Research, 28, 39–50.*

Aliotti, N. C., & Rajabiun, D. A. (1991). Visual memory development in preschool children. Perceptual and

Motor Skills, 73, 792–794. Boivin, M. J. (1991). The effect of culture on a visual-spatial memory task. *Journal of General Psychology, 118(4), 327–334.*

Bolla-Wilson, K., & Bleecker, M. L. (1986). Influence of verbal intelligence, sex, age, and education on the Rey Auditory Verbal Learning Test. *Developmental Neuropsychology, 2(3), 203–211.*

Brielby, N. (1999). *Teaching Reading.* Stanley Thornes: Cheltenham.

Crane, E. W., Huang, C.-W., Derby, K., Makkonen, R., & Goel, A. M. (2008). Characteristics of California school districts in program improvement (Issues & Answers Report, REL 2008–No. 055). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory West.

Cromley, J. (2009). Reading achievement and science proficiency: International comparisons from the programme on international student assessment. *Reading Psychology 30(2):89-118 ·*

Duncan, G.J., Dowsett, C.J.,Claessens, A., Magnuson K., Huston A. C., Klebanov P., Pagani L. S., Feinstein L., Engel M., Brooks-Gunn J., Sexton H., Duckworth K. &Japel C. (2007). School readiness and later achievement. *Developmental Psychology, 43(6); 1428-1446.*

Duru, A. & Koklu, O. (2011). Middle school students' reading comprehension of mathematical texts and algebraic equations. *International Journal of Mathematical Education in Science and Technology, 42(4), 447-468.*

Espin, C., & Deno, S. (1993). Performance in reading from content area text as an indicator of achievement. *Remedial & Special Education, 14(6), 47.*

Forrester, G., & Geffen, G. (1991). Performance measures of 7- to 15-year-old children on the Auditory Verbal Learning Test. *The Clinical Neuropsychologist, 5(4), 345–359.*

Freides, D., & Avery, M. E. (1991). Narrative and visual spatial recall: Assessment incorporating learning and delayed retention. *The Clinical Neuropsychologist, 5, 338–344.*

Geffen, G., Moar, K. J., O'Hanlon, A. P., & Clark, C. (1990). The Auditory Verbal Learning Test: Performance of 16–86 year olds of average intelligence. *The Clinical Neuropsychologist, 4, 45–63.*

Geffen, G., Moar, K. J., O'Hanlon, A. P., Clark, C. R., & Geffen, L. B. (1990). Performance measures of 16- to 86-year-old males and females on the Auditory Verbal Learning Test. *Clinical Neuropsychologist, 4, 45-63.*

Grimm, K. (2008). Longitudinal associations between reading and mathematics achievement. *Developmental Neuropsychology, 33(3), 419-420.*

Herlitz, A., Nilsson, L.-G., & Bäckman, L. (1997). Gender differences in episodic memory. *Memory and Cognition, 25(6), 801-811.*

https://cepa.stanford.edu/sites/default/files/Stipek%20%26%20Valentino,%20final.pdf

Huang, J. (1993). An investigation of gender differences in cognitive

abilities among Chinese high school students. *Personality and Individual Differences, 15(6), 717–719.*

Knox, R., *Bergstein, M*., *Seth*, R., Longo, J. & *McElveen*, N. (2010). Short Term Memory Based on Gender. https://scholar.google.com/scholar?psj=1&bav=on.2,or.&biw=1366&bih=659&dpr=1&um=1&ie=UTF-8&lr&cites=11521431924849199987

Kos, J. M., Richdale, A. L., & Hay, D. A. (2006). Children with Attention Deficit Hyperactivity Disorder and their Teachers: A review of the literature. *International Journal of Disability, Development and Education, 53, 147−160.*

Loonstra, A. S., *Tarlow* AR, *Sellers,* A. H. (2001). COWAT Metanorms across Age, eEucation, and Gender. Applied Neuropsychology; 8(3):161-166.

Quirk, M., & Beem, S., (2012). Examining the relations between reading fluency and reading comprehension for English language learners. *Psychology in the Schools, 49(6), 545-549.*

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

Robinson, N.M., Abbott, R.D., Berninger, V.W., & Busse, J. (1996).The structure of abilities in math-precocious young children: Gender similarities and differences. *Journal of Educational Psychology, 88(2), 341–352.*

Ruff, R. M., Light, R. H., & Quayhagen, M. (1988). Selective reminding tests: A normative study of verbal learning in adults. *Journal of Clinical & Experimental Neuropsychology, 11, 539-550.*

Savage, R., Lavers, N., & Pillay, V. (2007). Working memory and reading difficulties: What we know and what we don't know about the relationship. *Educational Psychology Review, 19, 185-221.*

Simpson, J. A., *Weiner,* E. S. C. (*1989)*.. The Oxford Dictionary. Oxford University Press. Oxford: Clarendon Press; Oxford; New York: Oxford University Press,

Stipek, D. and Valentino, R. (2010). Early Childhood Memory and Attentionas Predictors of Academic Growth Trajectories.

Temple, C. M., & Cornish, K. M. (1993). Recognition memory for words and faces in schoolchildren: A female advantage for words. *British Journal of Developmental Psychology, 11(4), 421–426.*

Ullman, D. G., McKee, D. T., Campbell, K. E., Larrabee, G. J., & Trahan, D. E. (1997). Preliminary children's norms for the Continuous Visual Memory Test. *Child Neuropsychology, 3(3), 171–175.*

Vilenius-Tuohimaa, P., Aunola, K., & Nurmi, J. (2008). The association between mathematical word problems and reading comprehension. *Educational Psychology, 28(4), 409-426.*

Widdowson, H. (1997). *Teaching and Language*. London: Longman.