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Impact of Working Memory on Academic Achievement of University Science Students in Punjab, Pakistan

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Abstract: Working memory is the ability to keep information current in mind for a short period, while using this information for the task at hand. It is the 'workbench' the 'screen' of computer where current thinking takes place. Students with working memory difficulties take a much longer time to process information. They are unable to cope with timed activities and fast presentation of information. As a result, they often end up abandoning the activities all together out of frustration. Research studies conducted previously point to that in general working memory was linked with academic achievement. In Pakistan, perhaps little research has yet been done in this field. The study was therefore; designed as working memory and academic achievement of science university students. The main objectives of the study were, to find out difference in working memory of male and female university science students and difference among working memory and academic achievement. The population of the study comprised of 300 male and female students studying in universities of Punjab, Pakistan. The sample consisted of 150 male and 150 female students of universities selected through multistage sampling procedure. In order to measure working memory of students, questionnaire was used. Academic achievement of students was measured through their university results. The results of the study revealed no gender difference. Both male and female were found to be equal in working memory and academic achievement.
Key words: working memory, academic achievement, science

1. Introduction

Working memory is 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 some-one 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, 2003).

Working memory is the ability to actively hold information in the mind needed to do complex tasks such as reasoning, comprehension and learning. Working memory tasks are those that require the goal-oriented active monitoring or manipulation of information or behaviors in the face of interfering processes and distractions. The cognitive processes involved include the executive and attention control of short-term memory which provide for the interim integration, processing, disposal, and retrieval of information. Working memory is a theoretical concept central both to cognitive psychology and neuroscience (Martinez, 2000). Working memory is a vital ability for storing short-term information, words and meanings (Pisoni & Cleary, 2003). 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) 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.

1.2 Working memory and science education

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. See Novice versus Expert Design Strategies

Research in psychology has revealed that scores on working memory tasks are a useful predictor of a number of cognitive skills. For example, scores are significantly correlated with performance on tasks of comprehension, counting, arithmetic, and reasoning (DeStefano & LeFevre, 2004) Scores also serve as a useful predictor of children's attainment in national curriculum assessments of English, mathematics, and science (St Clair-Thompson & Gathercole, 2006). Research exploring relationships between scores on working memory tasks and problem solving in science, however, has revealed mixed results. Roth (1990) found that working memory was significantly related to scores on science exams, and more so than performance on the figural intersection test .However, Vaquero et al. (1996) found that listening recall did not significantly predict science attainment, and suggested that this was a result of listening recall not being sufficiently cognitively demanding to predict problem solving (for similar arguments St Clair-Thompson, 2007).

Although researchers have referred to the working memory overload hypothesis in relation to science attainment associations between working memory and science have not been interpreted within the context of the multiple component model of working memory. Links between the phonological loop and visual-spatial sketchpad and science have also yet to be explored.

1.3 Implications for education

The Pascual- Leone approach to information processing characterizes performance in science is due to limitations in mental capacity. However, it does not provide an understanding of the cognitive resources underlying mental capacity. In contrast, research in to the multiple-component model of working memory (Baddeley, 2000) is vast and the functions of its subcomponents are relatively well specified. The multiple-component model suggests that cognitive performance is limited by a number of abilities storage capacities, processing efficiency, the ability to combine storage and processing, the ability to inhibit irrelevant information the quality of knowledge representations, and the ability to use efficient strategies. Thus the multiple-component model of working memory may provide detailed implications for educational practice (Dunlosky, et,al, 2007).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. Further research is needed to explore these possible interventions in relation to problem solving in science (Turley-Ames et.al, 2003).

1.4Research question

Following research question of the study was as follows:

1. Does working memory effects the achievement of science students at university level?

1.5Objectives of the study

The main objectives of the study were:

1. To find out difference in working memory of male and female science students
2. To find out difference among male and female science students on working memory and academic achievement.

2. Methodology of the study

The participants of the study will include male and female science university students. The population of the study consisted of university students, male and female. The multistage cluster sampling was used to select a sample of 300 students, 150 male and 150 female who were randomly selected from these selected clusters of university as a sample of the study. From each university 50 students were chosen. In order to measure working memory of students questionnaire was selected. The variable of academic achievement was measured by obtaining marks of the selected students from their university results. The nature of the study was descriptive. Data were collected through questionnaires survey from the universities by visiting them personally. The data was analyzed by calculating standard deviation. In order to compare male and female on motivational variable and academic achievement t-test (two tailed) was used.

3. Results and discussion

Table 3.1:- Frequency distribution of working memory scores of science students

Class intervals	frequencies
42-44	6
45-47	30
48-50	82
51-53	120
54-56	54
57-59	9

Table 3.1 shows frequencies of working memory scores. These scores were distributed in frequencies on the basis of each student's marks on the working memory questionnaire. The distribution of scores is normal because the frequencies are increasing up to the class interval 51-53 which has 120 students, thus falling gradually. The frequency distribution of scores is graphically represented in the figure 1 on the next page.

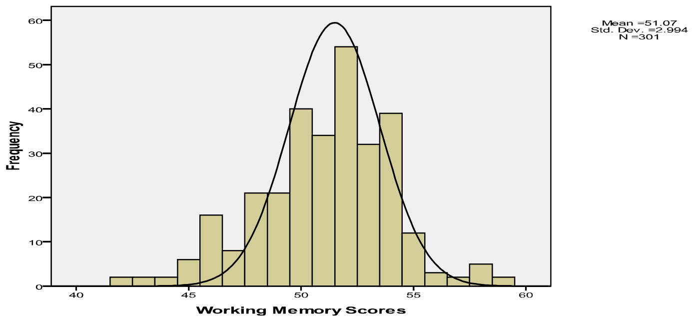

Figure 1:- Curve showing frequency distribution of working memory scores

Table 3.2: Significance of difference between mean working memory scores of male and female science students

Gender	N	Mean	SD	SE_{diff}	t	P
Male	150	51.31	3.2	.35	.15	≥.05
Female	150	50.82	2.8			

df= 298 t-value at 0.05 level=1.96

Table 3.2 shows that the mean working memory score of male students is 51.31 and mean of female students is 50.82, being almost equal. The difference between mean scores of male and female on working memory is statistically non significant. Since t-value is less at 0.05 level therefore, male and female students did not differ in working memory, both groups being moderate in the use of working memory.

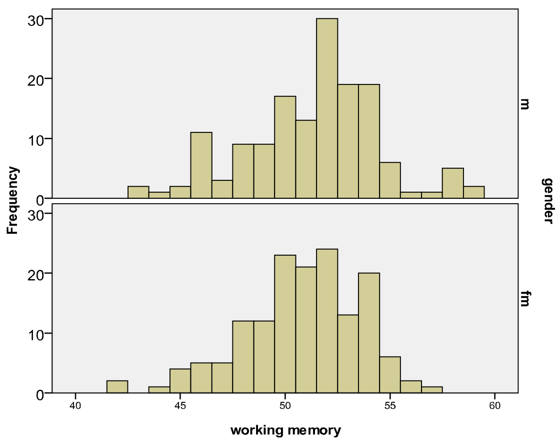

Table 3.3: Significance of difference between mean academic achievement scores of male and Female Students.

Gender	N	Mean	SD	SE_{diff}	t	p
Male	150	50.42	10.1	1.2	0.35	≥.05
Female	150	49.26	11.5			

df =598 t-value at 0.05 level=1.96

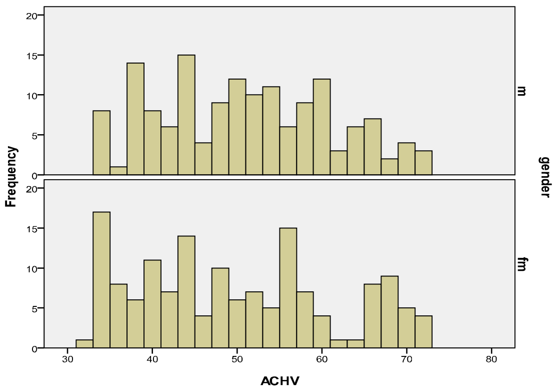

Table 3.3: shows that shows that the mean academic achievement score of male students is 50.42 and the mean of female students is 49.26, being almost equal. The difference between mean academic achievement scores of male and female students is non-significant. Therefore, there is no difference between academic achievement scores of both genders

4. Conclusions

The science students of universities were found to be equally inclined towards the use of working memory in their studies male had mean (51.31) where as female had (50.82) being almost equal. Their average academic achievement in the college examination result was below 50%.

5. Recommendations

Continues use of working memory is essential for maintaining concentration, purposeful thinking and mental effort during learning. Working memory research has shown that it is correlated to learning and reading. Because these areas are so important to all other learning, more research needs to be conducted to determine if working memory can be improved, then to develop activities and methods to improve it. An important outcome of this research must be to train to educators to realize the potential of focused activities and to encourage them to plan strategies to incorporate such activities in their daily work.

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