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The role of Metacognition on effect of Working Memory Capacity on students' mathematical problem solving

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The main objective of this study was to investigate the effects of Working Memory Capacity (WMC) on students' mathematical problem solving while considering different psychological factors. A sample of 256 high school girls students from Tehran (17-18 years old) were tested on (a) Metacognitive Awareness Inventory (MAI), (b) Mathematics Attention Test (MAT), (c) Mathematics Anxiety Rating Scale (MARS), (d) Digit Span Backward Test (DBT), and (e) a Mathematics Exam. Data of the present study were analyzed by descriptive and inferential statistics by T-test and Spearman correlation with the Statistical Package for the Social Sciences (SPSS). Results obtained indicate that metacognition had distinctive and challenging variable than other factors in use of WMC in mathematical problem solving. In other words, the correlation superiority between WMC and mathematical performance was found in group of high metacognition. Moreover, in each group of low/high metacognition, low/high math attention, and low/high math anxiety, the students with high WMC showed better mathematical performance than low WMC ones. The findings of the study are suitable for researchers who interested how different factors influence students' mathematical problems solving.

Keywords: Working Memory Capacity, Math Attention, Math Anxiety, Metacognition, Mathematical problem solving.

El rol de la metacognición en el efecto de la memoria de trabajo sobre la capacidad mental del estudiante para resolver problemas matemáticos. El principal objetivo de este estudio era investigar los efectos de la capacidad de memoria en el Trabajo (CMT) en los estudiantes, y la forma de resolver los ejercicios matemáticos planteados, mientras se consideraban diferentes factores psicológicos. En una muestra de 256 estudiantes mujeres entre los desde Teherán 17 y 18 años fueron evaluadas en a) Inventario conciencia meta cognitiva (ICM), (b) Prueba de atención Matemáticas (PAM), (c) Escala de ansiedad ante mas matemáticas (EAAM), (d) Prueba "Digit Span Backward", y (e) un examen de Matemáticas. Los datos del presente estudio se analizaron mediante estadística descriptiva e inferencial de T-test y correlación de Spearman con el Paquete Estadístico para las Ciencias Sociales (SPSS). Los resultados indicaron que la meta cognición tiene distintivos y distintas variables desafiantes que otros factores usados en el WMC en la resolución de problemas matemáticos. En otras palabras, la superioridad correlación entre WMC y el rendimiento matemático se encontró en el grupo de alta metacognición. Además, en cada grupo de baja/ alta metacognición, atención alta/ baja de matemáticas, y bajo altos niveles de ansiedad/ matemáticas, los estudiantes con alta WMC mostraron mejor rendimiento matemático de los bajos de WMC. Los resultados del estudio son adecuados para los investigadores que estén interesados en los diferentes factores que influyen en los problemas matemáticos que los estudiantes resuelven.

Palabras clave: Capacidad mental de trabajo, atención matemática, ansiedad matemática, meta cognición, resolución de problemas matemáticos.

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A large body of research has been investigated the effect of WMC on students mathematical problem solving (e.g., Alamolhodaei, 2009; Alloway, 2006; Mousavi, Radmehr & Alamolhodaei, 2012). However, how other factors effect on the relationship between WMC and mathematical problem solving haven't been explored in previous studies in depth. Therefore, this study tried to provide some clues about how mathematics anxiety, mathematics attention, and metacognition effect on this relationship. To aim this, at first literature about these factors are reviewed and then the sample of the study is divided to different groups based on students' responses to the questionnaires (i.e., mathematics attention, anxiety, and metacognition). Afterwards, the relationship between WMC and mathematical problem solving is studied in these groups.

Working Memory Capacity

Working memory refers to a mental workspace, involved in controlling, regulating, and actively maintaining relevant information to accomplish complex cognitive tasks (e.g., mathematical processing) (Raghubar, Barnes & Hecht, 2010, p. 110). It works in a few seconds, and helps us to focus our attention, confront distractions, and lead decision making. Individual with low working memory face difficulties in terms of efficiency and learning of both calculation and problem solving in higher levels (Klingberg, 2008).

There is growing evidence that Working Memory (WM) may be important for mathematical activities and mathematical deficits could result from poor WM abilities (Alamolhodaei, 2009; Alloway, 2006; Holmes & Adam, 2006; Mousavi, Radmehr & Alamolhodaei, 2012; Wilson & Swanson, 2001). This view is supported by some studies that WM is available indicator of mathematical disabilities in the first years of formal schooling (Gersten *et al.*, 2005). In addition, low WM capacity have been found to be closely related to poor computational skills (Wilson & Swanson, 2001) and poor performance on arithmetic word problems (Swanson & Saches-Lee, 2001). According to Alamolhodaei (2009), based on the students performance in math exams (word problems and ordinary exam), the students with high working memory achieved significantly higher results than low WM ones. Visuo-spatial memory as a sub-component of WM (Logic, 1995) is also closely linked with mathematical skills. It has been suggested that Visuo-spatial memory functions as a mental blackboard, supporting number representation, such as place value and alignment in columns, in counting and arithmetic (D'Amico & Gharnera, 2005; McLean & Hitch, 1999).

Children with poor Visuo-spatial memory skills have less mental room to keep the relevant numerical information (Heathcote, 1994). There have been several studies investigating possible contributions of WM capacities to learning problems in the classroom and whether these abilities differ as a function of severity of learning deficits

(Alloway, 2006). It has been reported that students with low WMC experience constrain learning in the course of their regular classroom activities (Allowat *et al.*, 2009). These students struggled in learning activities that placed heavy loads on their WMC.

Working Memory, Metacognition and Math Performance

Metacognition is a person's ability to think about their own thinking, beliefs, and mental processes. It is an important concept in cognitive theory to help students maximize the learning process and their meaningful understanding (Benjamin & Bird, 2006; Kratzig & Arbuthnott, 2009). Researchers have defined meta-memory, the aspect of metacognition related to our memory, consist of two basic processes that occur simultaneously, monitoring and control (Nelson & Narems, 1994). The first process monitors the situation of learning by students and the second make changes and adapts convenient strategies if he/she believes that they are not doing well.

According to Kratzig and Arbuthnott (2009), meta-memory strategies include skills for enhancing memory capacity such as chunking or grouping received information in meaningful ways or using repeated rehearsal to hold key facts in working memory for immediate use. Meta-memory skills are important in many academic circumstances. University students, for instance, required to learn a vast amount of difficult and unfamiliar information. They constantly make decisions about how much time to spend and what strategies to use learning the new academic information. Meta-memory accuracy or calibration (the correlation between predicated and observed memory performance) and planning (the correlation between predicted performance and study) can be improved with experience for both young and other adults (Kratzig & Arbuthnott, 2009).

Researchers have studied metacognition and how it relates to academic achievement and problem solving activities (Young & Fry, 2008; Alamolhodaei, Farsad & Radmehr, 2011). In addition, as Mayer (1998) found, metacognition is central in problem solving because it manage various components and skills required for mathematical performance. However, according to Alamolhodaei *et al.* (2011), there wasn't significant correlation between metacognitive ability and mathematical problem solving. In other words, the effect of metacogniton to mathematical performance wasn't directly to final path model. Metacognition had indirect effects to mathematical performance from math attention and attitude. This means that students with high metacognitive ability have more positive attitude and math attention than those who have low metacognitive ability and these lead them to better performance in mathematical task. But the effect of metacognitive ability to mathematical performance wasn't directly in that study according to final path model. This finding was supported by Sperling *et al.* (2004). Based upon these studies, it seems that students are not able to use metacognition knowledge because they almost have no idea about the metacognitive strategies.

Working memory and Attention

According to the literature, relation between attention and memory in the limited capacity system has been demonstrated (e.g., Cowan *et al.*, 2005; Styles, 2005). A large body of research has focused on WMC in students with learning difficulties in mathematics (Alamolhodaei, 2009; Alamolhodaei & Farsad, 2009; Bull & Scerif, 2001; Geary, Joarf, Byrd-eraven & Desto, 2004; Gerstan, Jordan & Flojo, 2005; Pezeshki *et al.*, 2011) and attention (Barkley, 1997; Martinussen & Tannock, 2006).

At least two dimensions of attention may be considered, the control of attention and its scope. The link between attention and WM has focused primarily on the control of attention, where as a meaningful scale of WM capacity depends on an emphasis upon the scope of attention (Cowan *et al.*, 2005). The control of attention and scope of attention are not necessarily in conflict. Individuals who excel at controlling attention could be the ones who have the largest scope of attention. Attention tended to be associated with executive control as a subcomponent of WM (Baddely & Logic, 1999; Styles, 2005).

Learners with low WM capacity are more likely to hear instructions from unattended channel in a dichotic listening experiment (Conway *et al.*, 2001). The work on the scope of attention also may be reflected to episodic buffer as a forth component of WM (Baddeley, 2000, 2001). The episodic buffer has the effect of integrating information from a variety sources and is controlled by the central executive. When individuals are learning a task, attention and conscious control are needed, but with practices, less and less conscious control is required until the tasks becomes automatic (Styles, 2005). According to Schweizer and Moosbrugger (2004), substantial link between attention and WM was observed. It indicates that measures of WMC include a component that it is also represented by measure of attention. This is the evidence supporting the original position of Baddeley (1986, 1992).

Some research recently reported that children with poor reading and arithmetic abilities scored poorly on test of both verbal and visuo spatial WM (Gathercole, Alloway *et al.*, 2006). According to Alloway, Gathercol, Kirkwood and Eliott (2009) the majority of research on WM and learning has demonstrated a relation among these two parts of WM (i.e., verbal and visuospatial components). It is possible that poor working memory skills are the cause of the learning difficulties encountered by children with dyslexia and attention deficit hyperactivity disorder (ADHD).

Math is a way of thinking and requires a great deal of attention, especially when multiple steps are involved in the problem solving process (Hajibaba, Radmehr & Alamolhodaei, 2013). In the classes, during teaching students who have attention difficulties often miss important parts of information. Without this information, students have difficulty trying to implement the problem solving process they have just learned when Z-demand (amount of information processing required by the math task) was increased; more attention would be needed to cope with its complexity. Taking notes and understanding a mathematical lecture are two different activities, but related to each other. Why is it so difficult to do both simultaneously? Is it because one can process only one source of information at a time? Ellis and Hunt (1993) noted that attention is the process allocating the resources or capacity to various inputs, attention is then important in determining which mathematical tasks are accomplished and how well the tasks are performed. Attention and consciousness have a close relationship that developed from the observation that conscious processing capacity is quiet limited.

Mathematical attention is a cognitive functioning which allocates the math information and Z-demands of tasks to a different level of consciousness. Therefore, with the increasing of consciousness, the mathematical attention would be developed. The process of attention could be help students to meaningful learning of mathematical activities. On the contrary, inattention is most commonly and widespread problems for learners. Inattention is a risk factor for poor mathematics achievement, and low WM is a causative (Tannock, 2008).

Based upon Alloway *et al.* (2009) findings, teachers typically judged the children with low WMC were highly inattentive and having poor attention spam and high levels of distractibility. These students often made carless mistakes, particularly, in solving problems in every day classroom activities and making high risk of poor academic progress, in particular, in math.

Mathematics Anxiety

Researchers exploring students' difficulties with mathematics courses (e.g., Hembree, 1990) have identified affective as prominent predictor (Ai, 2002; Alamolhodaei, 2009; Pintrich, 2002; Schreiber, 2002). Mathematics anxiety (MA) is a key variable can impede both learning (Fiore, 1999; Stuart, 2000) and mathematical problem solving (Alamolhodaei, 2009; Hembree, 1990; Ho *et al.*, 2000).

In addition, MA does not appear to have a single cause. It may be symptomatic of an inability to handle frustration, excessive school absences, poor self-concept, internalized negative attitudes toward mathematics (Jain & Dowson, 2009). As Richardson and Suinn (1972) defined, math anxiety is feeling of tension and anxiety that interfere with manipulation of numbers and the solving of mathematics problems in a variety of ordinary life and academic situations. Math anxiety often arise from a lack of confidence when working in mathematical situations (Stuart, 2000), and is often related to inappropriate of teaching mathematical skills (Jain & Dowson, 2009). Some studies have associated MA with students prior experiences of formal instruction in mathematics (Harper & Dane, 1998; Jackson & Leffingwell, 1999).

According to Alamolhodaie (2009), a relationship exists between learning styles (Field-dependent/independent), MA and students' working memory capacity. It was also observed that students with high math anxiety tend to show weak performance in the mathematical problem solving. Moreover, Field-dependent students tended to score higher on the math anxiety test than the field-independent students. In addition, the low working memory capacity students showed high math anxiety compared to the high capacity ones. Thus, math anxiety represents a bona fide anxiety reaction (Faust, 1992)with immediate cognitive implications that can also affect students’ future educational goals and aspirations (Jain & Dowson, 2009).

Research question and objectives

In recent years, various studies have shown that mathematical problem solving depend on mental capacity (e.g., Alamolhodaei, 2009; Mousavi *et al.*, 2012; Pezeshki *et al.*, 2011; Raghubar *et al.*, 2010). The purpose of this study is to investigate the effect of Working Memory Capacity on students' mathematical performance with different psychological factors. Thus, the main question addressed here is: ‘‘Is there any difference between effects of Working Memory Capacity on students' mathematical problem solving while considering different psychological factors?’’

In an attempt to answer this question the following objectives were sought:

The first objective of the study was to investigate whether students with high metacognition (HME), low metacognition ability (LME), high math attention (HMAT), low math attention (LMAT), high math anxiety (HMA) and low math anxiety (LMA) had different mathematical performance in term of low and high WMC. The second objective of this study was to discover the correlation between WMC and mathematical performance in these six groups (high/low metacognition ability, high/ low math attention, high/ low math anxiety). The third objective was to determine whether students within these groups: LMA+LMAT, LMA+HMAT, LMA+LME, LMA+HME, HMA+LMAT, HMA+HMAT, HMA+LME, HMA+HME, LMAT+LME, LMAT+HME, HMAT+LME, and HMAT+HME had different mathematical performance in term of low and high WMC. And the last objective was to discover the correlation between Working Memory Capacity and mathematical performance in these twelve groups (i.e., LMA+LMAT, LMA+HMAT, LMA+LME, LMA+HME, HMA+LMAT, HMA+HMAT, HMA+LME, HMA+HME, LMAT+LME, LMAT+HME, HMAT+LME, and HMAT+HME).

METHOD

Participants

256 school girls (17-18 years old) were selected from different high school across city of Tehran. For this purpose, random multistage stratified sampling design was used.

Procedure

The research instruments were:

(1) Metacognitive Awareness Inventory (MAI), (2) Mathematics Attention Test (MAT), (3) Mathematics Anxiety Rating Scale (MARS), (4) Digit Span Backward Test (DBT), (5) Mathematics Exam.

Metacognitive Awareness Inventory (MAI)

The MAI was used to measure students' metacognitive awareness. Schraw and Dennison (1994) developed MAI to assess metacognitive knowledge and metacognitive regulation which they referred to as the knowledge of cognition factor and the regulation of cognition factor. The MAI consists of 52 questions tapping into these two components of metacognition. Sperling *et al.* (2004) utilizing the MAI to determine college student metacognitive awareness, found a significant correlation between the knowledge of cognition factor and regulation of cognition factor. There are 17 questions related to the knowledge of cognition factor for a possible point total of 85.

There are also 35 questions related to the regulation of cognition factor for a possible point total of 175. The factor scores are calculated by adding the scores on questions reflected to each of the factors. Higher scores correspond to greater metacognitive regulation. In addition to the knowledge of cognition score and the regulation cognition score a MAI total score is derived by summing responses to all 52 questions. The instrument was designed for use on adult populations. Reliability for the MAI has been estimated to be 0.93. Students who scored above the sample mean were labeled as high metacognitive ability and those who scored less than the sample mean, as low metacognitive ability.

Digit Span Backwards Test (DBT)

For measuring the students' WMC, the DBT was used (Case, 1974; Scardamalis, 1977; Al-Naeme, 1988; Stone *et al.*, 1993; Alamolhodaei, 2009; Alamolhodaei & Farsad, 2009, Pezeshki *et al.*, 2011). The digits were read by one of the authors and the students were required to listen carefully, then turn the number over in their mind and write it down from left to right on their answer sheet. Students took the DBT twice within one and half month as test and retest. Students who scored above the sample mean were labeled as high WMC and those who scored less than the sample mean, as low WMC similar to previous study by Alamolhodaei (2009).

Mathematics Anxiety

Level of students' anxiety in math was determined by the score attained on the Math Anxiety Rating Scale (MARS), which had been used in the school of Mathematical Sciences, Ferdowsi University of Mashad. The MARS for this study was designed by Alamolhodaei (2009) according to the inventory test of Ferguson (1986). It consists of 25 items, and each item presented an anxiety arousing situation. The students decided the degree of anxiety and abstraction anxiety aroused using a five rating scale ranging from very much to not at all (5-1). Cronbach's alpha, the degree of internal consistency of MARS items for this study, was estimated to be 0.93. Similar to other variables, students who scored above the sample mean were labeled as high math anxiety and those who scored less than the sample mean, as low math anxiety.

Math Attention

A critical question is how to measure the scope of Attention (Cowan *et al.*, 2005). This measure conceived as the result of a limited-capacity attentional focus extracting chunk of information from a field of activated features in memory in order to allow an explicit memory response (Cowan, 2001). All participants were screened on a test to assess their scope of mathematical attention. In this task students respond to 25 questions which arranged according to Likert scale from very little to too much. Cronbach's alpha, the degree of internal consistency of mathematics attention test items for this research was estimated to be 0.91. This test has been administered before in previous studies (e.g., Hajibaba, Radmehr &Alamolhodaei, 2013).Students who scored above the sample mean were labeled as high math attention and those who scored less than the sample mean, as low math attention one.

Mathematics exams

The effectiveness of these psychological factors (Working Memory Capacity, Metacognition, Math Anxiety and Math attention) were investigated by the students' problems solving performance. Thus, a math exam with 4 parts as dependent variable was designed. The questions were in calculus field and each part has 100 scores. Therefore, the maximum score for each student would be 400, but the total score which a student may be obtaining in this exam was shown by TS. Then a score can be found for every student as a measure of her final performance in the exam. This final score (FS) could be calculated from the formulae: $FS={}^{TS}/_{400}\times 100$. Normality assumption for math exam was considered.

Table 1. Mean and standard divisions of variables in this study

Variable	Mean	*SD*
Metacognition	188.81	24..22
Math attention	89.63	13.39
Math attitude	71.57	15.85
Working memory capacity	4.60	1.82
Mathematical performance	47.10	17.73

Data analysis

Data of the present study were analyzed by descriptive and inferential statistics. Table 1 presents the means (M), standard deviations (SD) for variables in the study. Objectives of the study were analyzed by T-test and Spearman correlation with the Statistical Package for the Social Sciences (SPSS).

RESULTS

As to the first objective of this study, the result of t-test for two groups of LWMC and HWMC students showed that they had significant difference in terms of mean scores obtained in math exam with p-values that was shown in table 2 in each groups. Additionally it was shown that students' with HWMC had better performance than LWMC ones in these groups (high metacognition, low metacogniton ability, high math attention, low math attention, high math anxiety and low math anxiety).

Table 2. Students' mathematical performance in groups

Group	LWMC		HWMC		P-Value
	Mean	*SD*	Mean	*SD*	
Low Metacognition	43.84	16.40	54.80	15.80	0.003
High Metacognition	42.29	17.50	58.91	15.69	Less than 0.001
Low Math Attention	42.36	16.26	57.50	18.05	Less than 0.001
High Math Attention	44.05	17.59	57.31	13.22	Less than 0.001
Low Math Anxiety	43.57	16.46	56.22	15.47	Less than 0.001
High Math Anxiety	42.86	17.23	58.44	16.12	Less than 0.001

In regards of second objective of this study, a relationship was found between WMC and mathematical problem solving in groups. The Spearman's correlation between these variables was significant with P-values less than .001. Also according to table 3, the highest correlation between mathematical performance and WMC in theses six groups was shown in students with high metacognition and then students with high math attention while the lowest correlation between them was shown in students with low metacogniton ability and then students' with low math attention. Therefore, according to table 3, it can conclude that metacognition has the highest effect on effectiveness of WMC to mathematical performance.

Table 3. Correlation between Students' mathematical performance and WMC in groups

Group	P-Value	Spearman correlation	*N* (Sample size in group)
Low Metacognition	Less than 0.001	.315	129
High Metacognition	Less than 0.001	.560	127
Low Math Attention	Less than 0.001	.419	134
High Math Attention	Less than 0.001	.486	122
Low Math Anxiety	Less than 0.001	.453	110
High Math Anxiety	Less than 0.001	.435	146

As to the third objective of this study, the result of t-test for two groups of LWMC and HWMC students showed that they had significant difference in terms of mean scores obtained in math exam with p-values that was shown in table 4 in each group except students' with low math anxiety and low metacognition ability. Additionally, it was shown that students' with HWMC had better performance that LWMC ones in these groups.

Table 4. Students' mathematical performance in groups

Group	LWMC		HWMC		P-Value
	Mean	SD	Mean	SD	
LMA+LMAT	43.74	14.58	55.93	16.76	0.008
LMA+HMAT	43.41	18.30	56.44	14.79	0.011
LMA+LME	44.21	15.36	51.55	13.86	0.194
LMA+HME	42.83	17.82	57.95	15.94	.001
HMA+LMAT	41.48	17.30	58.61	19.25	Less than 0.001
HMA+HMAT	44.58	17.17	58.23	11.75	0.004
HMA+LME	43.59	17.18	56.52	16.88	0.007
HMA+HME	41.86	17.44	60.00	15.71	Less than 0.001
LMAT+LME	43.34	17.15	54.61	18.35	0.017
LMAT+HME	40.00	13.90	60.38	17.79	Less than 0.001
HMAT+LME	44.85	14.98	55.25	8.61	0.037*
HMAT+HME	43.54	19.20	57.92	14.39	.001

Finally, concern to the last objective of this study, significant correlations were found betweens students' mathematical performance and WMC in these groups except students with high math attention and low metacognition as shown in table5. According to this table highest correlation between students' mathematical performance and WMC was found in students with high math anxiety and high metacognitive ability While the lowest correlation between students' mathematical performance and WMC was found in students' with high math attention and low metacognition ability and then in students' with high math anxiety and low metacognitive ability.

Table 5. Effectiveness of working memory capacity on math performance in groups

Group	P-Value	Spearman correlation	N(Sample size in group)
LMA+LMAT	Less than 0.001	.428	53
LMA+HMAT	Less than 0.001	.477	57
LMA+LME	0.013	.348	50
LMA+HME	Less than 0.001	.494	60
HMA+LM.AT	Less than 0.001	.426	81
HMA+HM.AT	Less than 0.001	.502	65
HMA+LME	.008	.296	79
HMA+HME	Less than 0.001	.617	67
LMAT+LME	0.002	.324	87
LMAT+HME	Less than 0.001	.567	47
HMAT+LME	0.081	.273	42
HMAT+HME	Less than 0.001	.550	80

DISCUSSION AND CONCLUSION

The main aim of the present study was to examine the link between students' WMC and mathematical problem solving while considering different psychological factors. Therefore, the focus was to find the profile of students' mathematical performance with different WMC, metacognitive ability, math attention and anxiety. As can be inferred from the results, the WMC is a distinctive psychological variable to the students' mathematical problem solving in comparison to other variables. In other words, in each group of low/high metacognition, low/high math attention, and low/high math anxiety, the students with high WMC showed better mathematical performance than low WMC ones.

Moreover, the present study showed a significant relationship between students' WMC and mathematical problem solving in each category of metacognition, math attention and math anxiety (i.e., low/high metacognition, low/high math anxiety, and low/high math attention).The correlation superiority between WMC and mathematical performance was found in group of high metacognition. Finding of this study could support pervious claim that WMC may predict students mathematical problem solving performance (e.g., Alamolhodaei, 2009; Alamolhodaei & Farsad, 2009; Ashcraft & Kirk, 2001; Mousavi *et al*., 2012; Pezeshki *et al*., 2011; Talbi, 1990).

Based upon the third objective of the study and categories of metacognition, attention, and anxiety, students' with high WMC showed better performance in mathematical problem solving than low ones. In addition, the highest correlation was found between students' math performance and WMC in the groups of students' with high metacognition and high math anxiety. This finding showed that students with high metacognition ability can control their math anxiety and can use their high WMC better than other groups in situations of mathematical problem solving. These students change the effect of math anxiety on mathematical performance and the negative effects of high math anxiety was controlled and cause these students to work better in math problem solving and it's due to metacognition ability.

In students' with low math anxiety and low metacognition ability, there wasn't any significant difference between two groups of low/high WMC in mathematical problem solving as shown in Table 4. This finding showed that metacognition had great effect on using of WMC on mathematical performance. Because in this group, students had low math anxiety so they could use their WMC on mathematical problem solving but because they have low metacognition ability, they don't know how to use their high WMC in situation of math problem solving. On the other hand, according to Spearman correlation analysis, no significant correlation was found in group of high math attention and low metacognition ability, between WMC and mathematical problem solving. This finding again showed that metacognition had distinctive and challenging variable than other factors in use of WMC in mathematical problem solving. Because when students had high math attention, the correlation between mathematical performance and WMC was significant according to table 3; but when the low metacognition ability added this correlation decreased and changed to non-significant.

As a teaching strategy, math teacher should help and encourage students to reinforce their metacognitive and math attention skills that lead them to use their working memory capacity better in mathematical problem solving. The reduce of math anxiety and other noise could support students for meaningful of mathematical performance. To avoid loss of task information during working memory process, large units of math task demands must be chunked into single units, or conceptual and procedural entities (Alamolhodaei, 2009) to increase students' metacognitive and math attention abilities and reducing their math anxiety.

The findings of the present study were based upon the investigating carried out on female high school students. Therefore, further works need for finding more results for male students and in other levels.

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