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Effect of Cognitive and Metacognitive Strategies on Problem Solving and Educational Performance of College Students

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ABSTRACT

This study mainly aims to investigate the effect of learning metacognitive strategies on problem solving and performance of college students. The research is semi-experimental with pretest-posttest and a control group. The population of the study comprises all of 985 M.A. students of Tonekabon-based Islamic Azad University. The sample includes 30 students selected randomly and placed in experiment and control groups. The instruments utilized to collect data were 1) the Educational Package of Metacognitive Strategies in six 45-minute sessions administered to the experiment group. Three strategies of planning, control and supervision were the subjects of this package. 2) A researcher-designed questionnaire, consisting of 25 Lickert-type questions, that measures the components of problem solving. 3) Educational performance: in order to measure the educational performance of students, their average scores before and after the training sessions were used as the criteria. The collected data were analyzed by the multivariable analysis of covariance (MANCOVA). The results showed that:

- The training of metacognitive strategies is effective on problem solving and educational performance of students;
- The training of metacognitive strategies is effective on the improvement of students' problem solving skill; and
- The training of metacognitive strategies is effective on students' performance.

KEY WORDS: Metacognitive strategies, Problem solving, Educational performance

1-INTRODUCTION

Metacognition refers to our knowledge about our own cognitive processes and how to optimally use them in order to reach learning goals (Bayler& Snowman 2003). Metacognitive strategies are some measures to prudently choose appropriate methods, monitor their effectiveness, correct the mistakes and, when necessary, change strategies and replace them with new ones (Good and Brofi 2005).

The research on metacognitive strategies indicates that their implementation leads to the increase in learning (Beckman 2002). Such an effect is especially noticeable for those learners who are in some ways exposed to learning problems.

Metacognitive components involve the most general thoughts, beliefs, and executional skills apart from content, which are stored in individuals' long-term memory and retrieved when facing with cognitive assignments. Metacognitive components serve two significant functions: Not only do they include the knowledge related to cognitive matters and inform individuals about their thinking and cognition characteristics, but they also set the cognitive activities. The cognitive setting involves three essential skills of planning, review, and evaluation (Mohseni 2007). The metacognitive state is a kind of metacognition that has four components of metacognitive awareness, metacognitive strategy, planning, and self-review. Metacognitive state is defined as a transitional state of intellectual or rational situations of individual, which is highly fluctuating and varying through time. On the other hand, metacognitive trait refers to a relatively stable personal difference between individuals and their responses to rational situations or different degrees of metacognitive states (Onil and Abedi 2004, quoting Cetinkaya&Oktin 2006). Metacognitive control includes the conscious or unconscious decisions that we build upon the results of review processes (perfect &Shoartz 2004). The theoretical foundations as well as the literature suggest that metacognition and its components are related with problem solving and educational progress. Educational progress means success; it is used to determine the training advancements derived from mathematics, dictation etc. tests. Educational progress is acquisitive, learnable, and the final output of active learning process. The ability of problem solving, educational progress and educational performance depend on many factors that may affect individuals' performance in special circumstances. Metacognition is among those variables that are related with motivation, progress and the related variables. Metacognition is positively related to learning and discourse comprehension, and the process of metacognitive control and review interact with each other. Therefore, the knowledge of individuals about their abilities and their awareness about metacognitive strategies cause the improvement in learning and the enhancement of educational performance

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(August & Brady 2005).

Metacognition is positively related to learning. The students who belief they are more efficient take advantage from more metacognitive strategies and are more successful in solving their problems (Hafman&Spatario 2008). The capable and weak students in problem solving are different regarding metacognitive knowledge and using metacognitive strategies of review and planning. Research shows that there is a positive relationship between metacognition and metacognitive awareness on the one hand and learning and performance on the other hand (Sclifer&Dall2009), and the use metacognitive strategies is effective on learning new vocabulary as well as a second language. In addition, the relationship between metacognition and discourse comprehension, educational progress, decision making, happiness, and mastering of difficult texts is positive (Rezvan et al. 2006).

The study of Safari and Mohammad Jani (2011) with the title of *Application of metacognition in students experiences and its relationship with the level of educational progress* showed that there was a positive correlation between the components of metacognition and the average scores of students; such a correlation was significant regarding the strategies and methods of study and kinds of metacognitive knowledge.

The study of Zare and AhamdAbadi (2011) with the title of *Effect of learning metacognition by students in solving mathematics problems* indicated that the average scores of the group who attended the metacognition course was significantly higher than those of the control group. Overall, their study showed that the learning of metacognition and its approaches had a positive effect on the students' ability to solve their problems and their encouragement to learn mathematics.

Hall (2005) examined the ability of students of the fifth and sixth years in solving their problems after doing three assignments. He found that the provision of some particular trainings as well as metacognitive strategies (supervision and control) for the experiment group made them more capable of solving more difficult problems and solving problems faster than the control group.

Weinstein& Hume (2006) suggest in their work that teachers can, through teaching learning and study skills (cognitive and metacognitive strategies), help their students to become more successful learners and play a more active role in their educational fortune.

The review of the literature clarifies that the utilization of metacognitive strategies can be effective factors for the enhancement of individuals' learning. However, the previous studies mostly examined the effectiveness of these strategies on the psychological variables or solely the learning materials.

In the present paper, the researcher, with respect to the current experiences, sought to explore how the learning of met cognitive strategies affect problem solving and educational performance, which are different regarding their nature and level of difficulty. Therefore, the following hypotheses are set forth and evaluated in order to fulfill this objective:

1. Learning met cognitive strategies affects students' ability of problem solving and educational performance.
2. Learning met cognitive strategies affects students' ability of problem solving.
3. Learning met cognitive strategies affects students' educational performance.

2-METHODOLOGY

Population, Sample, and Sampling Method

This study is semi-experimental with the administration of pretest and posttest and inclusion of a control group. The population comprises all of the 985 Master's students of Tonekabon-based Islamic Azad University studying in the academic year of 2011-2012. The 30-participant sample was selected by random sampling method, which was divided into two 15-participant experiment and control groups with random replacement. In order to analyze the data, MANCOVA tests were used.

2-1-Research Instruments

A) Educational package of metacognitive strategies: It was administered in six 45-minute sessions to the experiment group, which involves the learning of planning, control, and regulation strategies.

B) Problem solving questionnaire: This questionnaire includes 25 Lickert-type questions, which is designed and compiled based on the theory of Glover and Browning (1998) and measures the components of problem solving.

C) Educational performance scale: In order to measure the educational performance of students, their averages of the semesters before and after the training course was used. The questionnaire's content validity was reached after making improvements requested by advisors and supervisors, and its reliability was calculated as 0.91 through Cronbach's Alpha coefficient.

3-Findings

In order to examine the research hypotheses, MANCOVA was used, since this statistical method allows the researcher to examine the effect of an independent variable on dependent variables and eliminates the effects of other variables. Before conducting this analysis, its presumptions; i.e. regression homogeneity, existence of a linear relationship, interval of data, normality of distribution, and randomness of data, and correlation between the data of dependent variables were investigated. The results showed that there was a **linear relationship** between problem solving and educational performance (dependent variables). in addition, the results of Box test indicated that it is not significant (BoxM = 3.3.16, F = (3, 141120.000) = 1.112, p = 0.343). Therefore, the assumption that Variance-Covariance matrixes are equal is not rejected. Further, with regard to the results of Leven's test and insignificancy of the dependent variables, the equality of variances is confirmed and the execution of MANCOVA is possible.

The statistical characteristics of problems solving and educational performance of the experiment and control groups are presented in table 1.

Table 1: Statistical characteristics of random and dependent variables in experiment and control groups

Variables	Experiment group		Control group	
	Mean	S.D.	Mean	S.D.
Problem solving pretest	55.86	3.22	50.06	3.99
Educational performance pretest	14.63	0.348	14.40	0.279
Problem solving posttest	64.86	3.54	51.066	3.990
Educational performance posttest	16.90	0.479	15.26	0.716

The above table shows that there is a difference between the mean scores of problem solving and educational performance of the experiment and control groups in the pretest and posttest. Such differences are to the advantage of the experiment group. The adjusted mean and the standard deviation of the dependent variables of the experiment and control groups are provided in Table 2.

Table 2: Adjusted mean and standard deviation of dependent variables in the experiment and control groups

Variables	Experiment group		Control group	
	Mean	S.D.	Mean	S.D.
Problem solving posttest	62.128	0.409	53.05	0.409
Educational performance posttest	16.811	0.195	15.351	0.195

We can observe the adjusted means of the dependent variables in Table 2. The effect of random auxiliary variables was removed statistically. The means tell us that the mean of variables in the experiment group are higher than that of the control group. The results of the multivariable covariance analysis are provided in Table 3.

Table 3: MANCOVA of F ratio for the measurement of combined variable

Source	Value	F (25, 2)	Sig.	Eta
Combined variable (group)	0.126	86.444	0.001	0.874

Note: Multivariable F ratio was calculated from Wilk's Lambda statistic

The square values of Eta, which are provided in Table 3, are a portion of variance andare related to a new combined variable (problem solving and educational performance). The general rule suggest that if the value is higher than 0.14, the level of effectiveness is high. In Table 3, such a value for the new combined variables, named group, was 0.874, which indicates a high effect. In addition, the results of Wilk's Lambda test on the combined variable are significant. Such a significance in the new combined variables shows that the participants of the two groups are different, and the mean scores of the groups are significant under the influence of the independent variable.

Table 4: Results of MANCOVA for problem solving and educational performance

Diffraction source	Sum of squares	d.f.	Mean of squares	F	Sig.	Eta
Problem solving	254.807	1	254.807	154.402	0.001	0.856
Educational performance	7.841	1	7.841	20.975	0.001	0.447

According to the results presented in Table 4, in order to analyze problem solving and educational performance of the experiment and control groups, Bonferroni'sadjusted alpha (0.025) was used. Since the resulted F from the comparison of the mean scores of problem solving in the two groups is significant at 0.01 level (F (1, 26) = 154.402, p = 0.001, η^2 = 0.856), we can suggest that there is a significant difference between the scores of problem solving posttest among the two groups. In other words, the learning of cognitive strategies is effective on students' educational performance.

Because the resulted F from the comparison of the mean scores of educational performance between the two groups is significant at 0.01 level (F (1, 26) = 20.975, p = 0.001, η^2 = 0.447), we can say that there is a significant difference between the posttest educational performance scores of the experiment group and control group. In other words, the learning of cognitive strategies is effective on students, educational performance.

4-Conclusion and discussion

This paper aimed to examine the effects of learning metacognitive strategies on problem solving skills and students' educational performance. Accordingly, the obtained results will be discussed as follows.

Regarding the first hypothesis, which points to the effectiveness of learning metacognitive strategies on problem solving and educational performance of students, the findings indicate that the Eta square values resulted from MANCOVA test, which is a portion of the variance related to the new combined variable (problem solving and educational performance), is 0.874; such a value is higher than 0.14 and point to the high effect of learning metacognitive strategies on the experiment group; in other words, metacognitive strategies can predict the level of problem solving and students' educational performance. In addition, the results of Wilks' Lambda test regarding the combined variable were significant, and the significance in the new combined variable demonstrates that the learning of metacognitive strategies enhance the level of students problem solving skills and educational performance. Such findings are consistent with the studies of Hall (2005), Anderson (2002), Hafman and Spatario (2008), Zare and Ahmad Abadi (2011), Weinstein and Hume (2006), Ebrahimi and GhavamAbadi (2008), Tan Saz and NematTavoosi (2011), Safari and Marzooghi (2010), Abdollahpour et al. (2010), Parvizi and Sharifi (2011) and a study in the research department of University of Oulu, Finland. The findings of these studies also suggest that learning metacognition and metacognitive strategies positively affect problem solving, educational performance and educational progress. In fact, based on the findings, we can say since learning metacognitive strategies regulates individuals' cognition and learning strategies, provide better ways for them, and increase their power of comprehension and analysis; they lead to the reinforcement of problem solving and the improvement of educational performance and progress.

As to the second hypothesis, pointing that learning metacognitive strategies is effective on students' problem solving skills, the findings of this study show that there is a difference between the mean scores of the experiment and control groups in the pretest and posttest that is statistically significant. Therefore, we can conclude that the learning of metacognitive strategies is effective on students' skills of problem solving. Such findings are consistent with the studies of Hall (2005), Anderson (2002), Haffman and Spatario (2008), Zare and Ahmad Abadi (2011), EbrahimiGhavamAbadi (2008), and the study by the Research Department of the University of Oulu (2006). These studies suggest that those students with more metacognitive strategies are more successful in solving their problems. In fact, since metacognitive strategies increase both individuals' knowledge about cognitive matters, characteristics of thinking, and cognition and regulate and reinforce their cognitive activities and comprehension, they lead to the improvement of problem solving skills. This is because cognitive strategies make individuals utilize prudent measures and appropriate methods for solving their problems and correcting their mistakes.

With respect to the third hypothesis, which refers to the effectiveness of learning metacognitive strategies on students' educational performance, the findings of this study indicate that there is a significant difference between the educational performance posttest's mean scores of students of the experiment and control groups (1.460). therefore, we can suggest that the learning of metacognitive strategies is effective on students educational performance.

These findings are consistent with the studies of Tan Saz and NematTavoosi (2011), SalariFard and Pakdaman (2009), Weinstein and Hume (2006), Safari and Marzooghi (2010), Parvizi and Sharifi (2011), Bashaverd et al. (2009), Safari and Mohammadjani (2011). These studies have indicated that the learning of metacognitive strategies is effective on the educational performance and progress of students.

In fact, we can say since metacognitive strategies actually reform the learning methods of students and lead to a better and greater learning, they improve students' educational performance.

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