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Predicting the Mathematical Performance of the Students Based on the Dimensions of Metacognition Condition

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ABSTRACT

The aim of this research was to study the prediction power of the dimensions of metacognition condition in determining mathematical performance condition of students at 3th grade in middle school. This research is descriptive and of correlation type, that mathematical performance as criterion variable and the metacognition condition as prediction variable have been considered. The research society included all of students in Shiraz and sample included 240 students (120 boys and 120 girls) from 8 middle school (4 schools for boys and 4 schools for girls) in district 2, Shiraz, which have been selected by cluster sampling method. For collecting information they used teacher-made math test & metacognition condition test (SMI).The results of Stepwise multiple-variable regression analysis indicated that among the dimensions of metacognition condition , the dimensions of awareness, planning and cognitive strategies, better predict the math score of students

KEYWORDS: Prediction, Meta Cognition Condition, Mathematic

1. INTRODUCTION

One of the basic issues in contemporary psychology and education is the concept of learning. Regarding the importance of learning, one of the most important tasks of education, is how to educate learning to students for effective use in their life. In the past, it was thought that learning ability in individuals is a function of their intelligence and talents, but in recent years, psychologists emphasized that in addition to intelligence as an intrinsic factor, other factors also are effective in learning process.

According to the definition, the cognitive strategies are the learner's each behavior, action or thought that he or she uses while learning and is aimed at contributing to learning, organizing and saving the knowledge and skills and facilitating their utilization in the future Weinstein and Hume [1]. These strategies contribute to creating and increasing knowledge and cognitive processes. These strategies include several strategies that Weinstein et al. believe that it includes remembering, elaboration and organization Weinstein and Mayer [2]. These strategies are in relation with the educational performance Pintrich [3]. Metacognition refers to any knowledge or cognitive process in which there exist the assessment, monitoring and cognitive control. Flavell [4] and Mose and Baird [5.]

On the other hand, it can be considered as a general aspect of cognition which has a role on all cognitive activities Wells [6]. Metacognition has also great influence on the educational progress of the learners, and the social environment and language have special importance on increasing and improving learners` metacognition skills Thomas [7].

The nature or structure of metacognitive learning environments often is recognized by the discussions that are made about them and have important role in students` metacognitive knowledge development [7, 8]. Therefore, the discussion based on the free and active exchange of ideas and thoughts about learning between teacher and students, results in students metacognitive skills improvement and development [9].

Today, the importance of metacognition for high levels learnings and problem solving is accepted [10]. Learners can have the maximum successful learning, when have good awareness and insight about their personal abilities. Researchers have found that if the metacognition level of students improves, their learning outcomes will also improve [10,11]. The more the learner knows about learning effective strategies and his learning ability and memory constraints, he is more likely to increase his educational achievements Burke, Laura [13].

Other factor that influences the cognitive learning is language that is the foundation of all higher cognitive processes such as attention-controlled, deliberated memory, planning, problem solving and reflection. Burke Laura [13] has an important role in improvement and development of learner's metacognition skills [9, 10]. Researchers believe that applying such skill can lead to increasing metacognitive skills in students McGuinness et al. [14]. Researchers have found that if the level of students metacognition improves, their learning outcomes also will improve [11,12]. The more the learner knows about learning effective strategies and his learning ability and memory constraints he is more likely to increase his educational achievements [13].

The concept of metacognition is a multifaceted concept which includes knowledge, beliefs, processes and skills to assess, supervise or control the knowledge [15, 16]. Many theorists have studied the topic of the meta cognition condition that one of them is metacognition condition [17]. In this theory, metacognition condition is determined as a transient state in mental status which fluctuates in terms of intensity and changes over time and

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includes planning, self-monitoring strategies , cognitive and awareness strategies .These strategies have been validated in several experimental researches (Conducted researches on cognitive and metacognitive strategies have shown that the use of these measures will lead to an increase in students' learning [16].

Metacognitive skills can have an important role in transferring the learning to real life situations, people have an important role [18, 19]. In this respect, Dominowski [20] believes that at the time of solving problem, paying attention to the use of metacognitive strategies such as monitoring, planning, and checking result in individuals` better performance and transfer of learning cited from Good and Brophy [21]. In this research, metacognition condition is considered that includes planning, monitoring strategies, cognitive and awareness strategies and has been adapted from Lobban et al. [16]. The meaning of metacognitive strategies is the measures necessary for conscious choice of appropriate methods, monitoring their effectiveness, correction of errors and, if necessary, changing strategies and replace them with new strategies. Therefore, metacognition has an aspect of data processing system that undertakes the monitoring, interpreting, and evaluating the learning content and process of the organizing data processing system Good and Brophy [21].

In one research called developing assessment tools for learning and study strategies and finding the relationship between these strategies and high school students education achievement, Karami [22] concluded that; 1- The clever students make more use of study and learning strategies compared to the poor students; 2- Utilizing the all strategies is correlated with educational achievement; 3-By using the scores obtained from learning and study strategies, the educational achievement can be predicted by means of regression equation and in this case, knowledge and self-control has the greatest capability in the educational achievement In one research, teenage students in New York with high learning talent and low training talent , were compared in use of reading metacognitive strategies, although the results didn't show any specific difference, but repeating the use of that method, especially in control, highlighted this issue that gifted students used convergent method more strategies on students `comprehension at first grade of elementary school. Linda & and low talented students used divergent methods Kolb and Kolb [23]. In a research named "metacognitive Pinkleyey [24] concluded that teaching metacognitive strategies is effective to increase comprehension skills of students, they also concluded that teaching these strategies shouldn't be limited to understand a particular text. Weinstein and Hume [25] in an article entitled metacognition has mentioned that students who use metacognitive strategies are more successful than students who don't use these strategies. In a research, Weinstein and Hume [25] stated that teachers can help their students by teaching cognitive and metacognitive strategies in order they have active role in their educational status and be successful learners. The researches conducted by Bshavrd [26] and Pintrich [27] acknowledges that cognitive regulation and utilizing metacognitive strategies can affect the effectiveness of learning and result in students' educational achievement and advancement; he showed that self-regulated learning can be facilitated by adopting subtle goals about assignments; moreover, it may be inhibited by adopting unnecessary and useless goals. Zimmerman [28] taught cognitive and metacognitive skills to the third and fifth grade students. The results obtained from this research showed that the students who had been taught this kind of skills (the experiment group) were more able to read and understand compared to the students who did receive such instructions (the control group) ed. that teaching metacognitive strategies have influenced educational performance of male students and their creativities. Wells [29] based on a research, reported that metacognitive beliefs in patients with anxiety disorders, especially in generalized anxiety disorder, panic disorder, obsessive-compulsive disorder and post-traumatic stress disorder is more impaired.

Metacognition, which we consider and enter into the domain of our consciousness, shapes the evaluations and the effect of different strategies that we use to adjust our thoughts and feelings. Regarding to the fact that mathematics is one of the important lessons in educational period, it is required that cognitive and metacognitive capabilities of learners be studied in learning this lesson, in order to use the necessary cognitive and metacognitive strategies in teaching information to the students. Therefore, although some researches have been performed on meta-recognition, but it seems that, in Iran, no research have been conducted about predicting the math scores through metacognition condition dimensions. Accordingly, the aim of this study is to determine which aspects of metacognition dimensions can better predict students' math performance.

This research is descriptive (correlation) in which math performance as criterion variable and metacognition dimensions as prediction variable have been considered.

2. MATERIALS AND METHODS

Society and sample

The study population consisted of all middle school students for boys and girls who were enrolled in the district of 2 in the city of Shiraz. Sample of the present research, were 240 subjects (120 males and 120 females) from grade 3 of middle school students who have been selected by purposive sampling. The students were enrolled in District 2 of Shiraz and were almost identical in social and cultural conditions of residence, education district, school of education, conditions and opportunities of education place, quality of education and condition of education, age characteristics and education grades. In this study, 2questionnaires were used to collect data.

1. Math learning test: Materials used to assess students' mathematics learning is teacher-made tests, which was prepared based on two-dimensional table and its questions were arranged based on Bloom's cognitive

function from application class to upward. To prepare this test, three psychology expert researcher and 4 experts in mathematics participated. With above mentioned experts` view, questions were designed that were in accordance with the teaching method with metacognition style. These questions have been designed in such a way that they evaluated students metacognition power in solving mathematical cases. In the end, to estimate the reliability of test scores, test sheets were further corrected by another teacher.

2. **Metacognitive condition scale:** To evaluate the awareness of metacognitive condition strategies, the (SMI) scale has been used. This scale includes 20 items that has been designed by O`neill and Abedi at the University of Southern California in 1996. This scale is a pencil paper scale that has 20 items and four subscales: Knowledge and awareness (17, 13, 9, 5, 1), cognitive strategies (19, 15, 11, 5, 3), Planning (20, 16, 12 , 8, 4), and self-monitoring (18, 14, 10, 6, 2), that for every subscales, five items are dedicated and each item on a four-point Likert scale, never (scientific value of 1) to very high (scientific value of 4) is graded. The range of scores in this scale for each subject fluctuates from 20 to 80. In this study, to evaluate the stability of questionnaire, Cronbach's alpha has been used, and to assess the validity, the subscales` correlation with each other and with total score has been used that its results are presented in Table 1.

Table 1. Stability of metacognition questionnaire subscales

Subscale	Stability
Awareness	0.84
Planning	0.82
Cognitive strategies	0.79
Self-regulation	0.81

3. RESULTS AND DISCUSSION

To assess the data subjects properties have been investigated by descriptive statistics, that its results are mentioned in Table 2.

In the following, scores for subjects were analyzed by using stepwise multiple variables regression analysis. For this purpose, mathematic score as criterion variable and metacognition dimensions (Awareness, self-regulation, cognitive strategies and planning) entered the analysis as prediction variables to determine which of these dimensions can be proper predictors of math scores that in Table 3, the prediction of students' math scores is mentioned based on the dimensions of the metacognition condition.

Table 2. Mean and standard deviation of male and female (boys and girls) students

Gender	Percentage	Number
Boy	%050	120
Girl	%050	120
Total	%100	240

Table 3. The analysis of multiple variable regression of students' math scores based on the dimensions of knowledge (awareness), planning and cognitive strategies

Prediction variables	Stage 1		Stage 2		Stage 3	
	T	B	T	B	T	B
Awareness	37.17	0.750	45.6	0.430	39.4	0.33
Planning			86.5	0.39	30.4	0.30
Cognitive strategies					96.2	0.22
R	0.78		0.75		0.79	
^{2}R	0.61		0.56		.63	
Significance	0.001		0.001		0.003	

Based on Table 3 data, the ratio of observed R2 for regression analysis, in first step (predicting math score from awareness variable) is significant (B=0.75, R2=0.56, p<0.001). Based on above results, 56% of math score is explainable by subscale of metacognition condition awareness. On second step, the ratio of observed R2 for regression analysis, (predicting math score from planning variable) is significant (B= 0.39, R2=0.61, P<0.001). When the subscale of planning is added, it increases the prediction of math score for 0.6. Meaning 61% of mathematic score will be explained by awareness and planning strategies.

Also in third step, when the cognitive strategies entered in analysis, the ratio of observed R2 for regression analysis (mathematic score from planning variable) is significant (B=0.22, R2=0.63, P<0.003). In this stage the amount of R2 has increases by 0.2. Meaning 63% of mathematic score will be explained by awareness, planning and cognitive strategies.

In this study, the other dimension of metacognition (self-control) has been removed by computer, because it couldn't predict the mathematic score. So, based on the offered model by computer and according to

results of Table 3, it has been determined that awareness, planning and cognitive strategies respectively can better predict students mathematic performance.

To answer this question, the stepwise multiple variable regression analysis has been done .According to Table 3, in first stage, among metacognition dimensions, awareness with R2= 0.56, is better predictor for mathematic score of students. Based on this, id the student be aware of his thinking, he will notice how to think and where to use it. Also he will learn to do his work by plan and will understand how he is thinking and what is going on in his mind ,also he tries to respond each question after he really understand it. Therefore, besides having the ability to these capabilities, learner can have significant progress in academic achievement. The analysis revealed that 56% of the math score is explainable by Metacognition situation `awareness subscale.

At second stage, when the planning subscale is added, R2 amount increases for 0.6 and this subscale increases 6% the prediction of mathematic score. It means that when, in addition to learning the awareness strategies, students learn planning strategies, these 2 variables, in sum, can predict 61% of mathematic score.

At third score, when cognition strategies enter the analysis, in addition to awareness and planning dimensions, the R2 increases for 0.2, and this subscale (cognitive strategies) will increase 2% of mathematic score prediction. It means that when students learn the cognitive strategies besides awareness and planning strategies, these 3 variables, in sum, can predict 63%of mathematic score. These findings are not in consistent with Salehi and Valiallah [30] that indicated: among metacognition situation strategies, only self -regulation strategy can predict English score. Also these findings are not in line with generally, this study showed that utilizing the metacognition strategies is effective in students' achievement and enhances their learning. This result is in consistent with the foreign research results such as Weinstein et al. [25], Motavaly [31] and Garner [32].

The researcher argues that since among the meta-cognition situation subscales, awareness subscale plays more important role to familiarize students and better learning meta cognition, also in metacognition situation , learner should come to this capability that to know why he should use this information and method, how he should use and where he should use each of previous information. Therefore, if learner has this capability (awareness), he can use better the other metacognition situation strategies in the learning and responding process .So it can be said that, this awareness strategy can better predict student academic achievement.

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