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THE IMPACT OF METACOGNITION TRAINING ON METACOGNITIVE AWARENESS OF MEDICAL STUDENTS

(TIP FAKÜLTESİ ÖĞRENCİLERİNDE ÖĞRETİMLE YÖNLENDİRMENİN METABİLİŞSEL FARKINDALIĞA ETKİSİ)

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ABSTRACT

Metacognition is the knowledge and regulation of one's own cognitive system. Possession and use of metacognitive abilities is necessary for learning and the learners who are metacognitively strong are best prepared to learn throughout their lives. Medical students must be prepared to cope with the uncertainty and evolving understanding inherent in medical practice. The study examined the metacognitive awareness of medical students and the impact of metacognitive training on their metacognitive awareness. In this research, mixed methods design was used. In the quantitative research *pre- and post- test control group* experimental research method was used. Two-way repeated measures of analysis of variance (ANOVA), Bonferroni corrected repeated measures of ANOVA, Bonferroni corrected Mann-Whitney U test were used for analyses. In the qualitative research, 6 open-ended questions were asked to the experimental group. "Content analysis" was used to analyze the 6 open-ended questions which students answered. The research group consisted of 63 first-year (2007-2008) medical students (30 tests, 33 controls) of Ankara University School of Medicine. Metacognitive Awareness Inventory-MAI was used to determine the students' metacognitive awareness. MAI scores of both post-test and follow up test were higher than pre-test scores in experimental group (p=.003 and p=.043, respectively), while there could not be found any statistically significant differences in control group (p=.215). Metacognitive capabilities can be enhanced by training. Informing the students about metacognition and life-long learning, and helping the educators in realizing the importance of metacognition can help the students learn how to learn.

Key words: Metacognition, metacognitive awareness, medical education, undergraduate, lifelong learning.

ÖZET

Metabiliş, kişinin kendi bilişsel sistemini bilmesi ve onu değerlendirmesidir. Yaşam boyu öğrenme paradigmasının gerçekleşmesi ve mesleğini uygulamada uzman tıp doktoru olmak için metabiliş önemli ve gerekli bir bilişsel süreçtir. Tıp öğrencilerinin, klinik uygulama ve öğrenmedeki karışıklıkların yönetilmesinde başarılı olabilmeleri için metabilişsel becerilerini geliştirmeleri gerekir. Bu kapsamda, bu çalışmada tıp fakültesi öğrencilerinin metabilişsel farkındalık düzeyleri ve bu farkındalığı arttırmak amacıyla düzenlenmiş olan eğitim sürecinin öğrencilerin metabilişsel farkındalık düzeylerine olan etkisi araştırılmıştır. Araştırmada nicel ve nitel araştırma yaklaşımlarının bir arada olduğu karışık yöntemler deseni kullanılmıştır. Nicel bölümde gerçek deneme modellerinden ön *test-son test kontrol gruplu* deneysel model kullanılmış, bir yıl sonra da izleme testi uygulanmıştır. Verilerin çözümlenmesinde iki faktörlü ANOVA ve Mann-Whitney U testi ve Bonferroni testi kullanılmıştır. Nicel bölümde öğrencilerin metabilişsel farkındalıkları hakkında ayrıntılı bilgi alabilmek ve bu konuda onlara eğitim vermek amacıyla altı adet açık uçlu soru ve her soru için de bilgilendirme amaçlı eğitici cevaplar geliştirilmiştir. Bu soruların cevapları, nitel veri toplama aracı olarak kullanılmış ve verilerin analizinde içerik analizi uygulanmıştır. Çalışmanın araştırma grubunu Ankara Üniversitesi Tıp Fakültesi 2007-2008 Eğitim Öğretim Yılı Dönem 1 öğrencilerinden 63 öğrenci (30 deney, 33 kontrol grubu) oluşturmuştur. Araştırmada öğrencilerin metabilişsel farkındalık düzeyini ölçmek için Bilişötesi Farkındalık Envanteri-BFE kullanılmıştır. Sonuçlara göre deney grubundaki öğrencilerin, kontrol grubundakilere göre Bilişötesi Farkındalık Envanteri puan ortalamalarının deney öncesinden sonrasına ve bir yıl sonrasına göre anlamlı farklılık gösterdiği bulunurken (p=.003 and p=.043), kontrol grubu ile diğer

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gruplar arasında anlamlı fark olmadığı görülmüştür (p=.215). Eğitimle metabilişsel becerilerin arttırılabileceği gösterilmiştir. Bu çalışma, eğitimle metabilişsel becerilerin geliştirilebileceğini gösterirken, öğrencilerin öğrenmeyi öğretmek için metabiliş ve yaşam boyu öğrenme konularında bilgilendirilmesi ve aynı şekilde eğiticilere de metabilişin öneminin hatırlatılması gerekliliğini göstermektedir.

Anahtar kelimeler: Metabiliş, metabilişsel farkındalık, tıp eğitimi, mezuniyet öncesi, yaşam boyu öğrenme.

INTRODUCTION

An important purpose of higher education is that graduates are expected to develop more advanced, academic and independent ways of learning. The demands of the twenty-first century require students to know more than content knowledge; they must know how to learn. In this context professionals in education are increasingly acknowledging the importance of metacognition for learning. Possession and use of metacognitive abilities is necessary for learning and the learners who are metacognitively strong are best prepared to learn throughout their lives.

In the early 1970s, the concept of metacognition was introduced by John Flavell. He defined metacognitive knowledge; as one's stored knowledge or beliefs about oneself and others as cognitive agents, about tasks, about actions or strategies, and about how all these interact to affect the outcomes of any sort of intellectual enterprise. Flavell defined metacognitive experiences; as conscious cognitive or affective experiences that occur during the enterprise and concern any aspect of it—often, how well it is going (Flavell, 1979). In another words, metacognition refers to individuals' awareness of and control over the way they process information (Meltzer, Pollica, & Barzillai, 2007). Quirk defined metacognition as thinking about one's own or another's thoughts, feeling, and values (Quirk, 2006). Metacognition is a special type of knowledge and ability that develops with personal experience and with schooling. Most theorists believe that the development of metacognitive knowledge begins at a young age, and continues at least through adolescence (Schraw & Moshman, 1995; Zohara & Barzilaib, 2013). There is no universally accepted definition of metacognition, many researchers agree on common fundamental components of metacognition; knowledge of cognition and regulation of cognition, which are both viewed as important for effective learning. Knowledge of cognition refers to what individuals know about their own cognition and it includes three different kinds of metacognitive awareness: declarative, procedural, and conditional knowledge. Regulation of cognition which includes planning, monitoring, and evaluation, refers to a set of essential skills that help students control their learning. In exercising metacognitive monitoring and metacognitive control, learners actively engage in thinking about their learning and factors that bear on learning (Winne & Baker, 2013). These two components of metacognition are related to one another and both components appear to span a wide variety of subject areas and domains – that is, they are domain-general in nature (Schraw, 1998). Consequently metacognitive skills include taking conscious control of learning, planning, monitoring the progress of learning, identify personal strengths and weaknesses, and undertake appropriate remediation, besides selecting

strategies, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies when necessary (Dunlap, 2005; Turan, Demirel, & Sayek, 2009).

The new paradigm in medical education that prepares medical students for a lifetime of learning must also prepare them for a lifetime of practice and managing complexity. The Tomorrow's Doctors vision of a competent practitioner with a wider `world-view' includes realistic notions of scientific evidence guarded by reflective skepticism, and this requires metacognition. Metacognition is a concept that attempt to capture the essence of adapting to change and uncertainty. Doctors' self-understanding and insight into the nature and limitations of their knowledge, and their capacity to apply it are crucial (Maudsley & Strivens, 2000). In medicine and other professions that focus on problem solving and human relations, these capabilities would include the abilities to self-monitor and regulate performance in complex situations (Quirk, 2006). Metacognition enables students to coordinate the use of current knowledge and a repertoire of reflective strategies to accomplish a single goal. In medicine, metacognition can also be defined as checking the diagnostic thinking for possible bias, seeing the illness from patient's perspective, or assessing what you need to know about a treatment option.

According to the previous research results, students who use metacognitive strategies are more academically successful than students who do not use these strategies. Moreover, students can be taught to improve metacognitive proficiency through repeated guided practice (Schellenberg, Negishi, & Eggen, 2011; Schraw, 1998). Teaching approaches using strategies which emphasise student metacognitive and self-regulated learning is among the most effective approaches (Zohara & Barzilaib, 2013). Metacognitive awareness, therefore, serves a regulatory function and is essential to effective learning because it allows students to regulate numerous cognitive skills (Howard, McGee, Shia, & Hong, 2000). Consequently investigating metacognitive awareness of medical students is very important in order to evaluate the curriculum and to modify it as necessary (Turan, Demirel, & Sayek, 2009). Also determining metacognitive awareness levels is a crucial issue for medical students because metacognition can be improved through curriculum planning and teaching.

The aim of the study is;

- To examine the metacognitive awareness of medical students and
- To examine the impact of metacognitive training on their metacognitive awareness.

METHODS

In this research mixed method design which involves both quantitative and qualitative methods was used to explore the answers to our research questions. Mixed method research is particularly useful for gaining a better and complex understanding of the particular topic (Wilson & Bai, 2010). In this research design,

qualitative data was used to clarify, delineate and recover the quantitative results (Lodico, Spaulding, & Voegtle, 2006).

Within the context of the quantitative research *pre- and post- test control group* experimental research method was used and one year later a follow up test was applied to track the progress. In the qualitative research 6 open-ended questions were asked to the experimental group by e-mail. Feedback and "the facilitative, training aimed educatory answers of metacognition" were given to the students' each answer one by one.

Participants

The research group consisted of 63 (n= 317) first year medical students who were asked to contribute to the study voluntarily at Ankara University School of Medicine in 2007-2008. Students were not compensated for their participation.

Among the 63 medical students, who were selected randomly 30 were experimental group, and 33 were control group. In mixed method design, the study may begin with a quantitative method in which theories or concepts are tested, to be followed by a qualitative method involving detailed exploration with a few cases or individuals (Creswell, 2003). 55.6 % of them were female and 44.4 % of them were male. The gender distribution of groups was similar (p=.176). The mean age of the students was 19.55 (SD= 0.82) years, their age range was 18-21. There was no difference between groups in terms of age (p=.194).

A year later in the follow up test, 2 of the students (1from experimental group and 1 from control group) were dropped out (n=61).

Instruments

Metacognitive Awareness Inventory-MAI

Metacognitive Awareness Inventory-MAI was used to determine the students' metacognitive awareness which was designed by Schraw and Dennison (1994) for use with adults (Schraw & Dennison, 1994). The MAI is a 52-item self-report inventory and each item is rated on 5-Point Likert-type scale which ranges from "1-always false" to "5-always true" to report respondents' level of agreement with the 52 items. High scores indicate strong agreement. Items were classified into eight subcomponents subsumed under two broader categories, knowledge of cognition and regulation of cognition. Two experiments supported the two-factor model. Factors were reliable (i.e., α =.90) and inter-correlated (r =.54) (Schraw & Dennison, 1994).

Turkish translation and validity-reliability studies were done by Akın, Abacı and Çetin (2007). Results of exploratory factor analysis have demonstrated that the items loaded on eight factors under the knowledge of cognition and regulation of cognition dimensions. The internal consistencies of the MAI, were found .95 for the entire scale, and were found ranged between .93-.98 for subscales. Test-retest reliability coefficient of MAI over three week period was .95 (Akın, Abacı, & Çetin, 2007).

Experimental Treatment for Enhancing Metacognitive Awareness

An experimental treatment which was composed of 6 open-ended questions was designed and "the facilitative, training aimed educatory answers of metacognition" for each question was given in order to enhance metacognitive awareness (Table 1). The answers of the students to the questions were used as an instrument for the qualitative analysis.

6 open-ended questions and "the facilitative, training aimed educatory answers of metacognition" for each question were used for qualitative research data collections which were prepared compatible with the MAI, Taxonomy of Metacognitive Activities (Meijer, Veenman, & Van Hout-Wolters, 2006) and problem-solving. One educational psychologist and one cognitive psychologist reviewed the questions and answers, in order to produce the final form. The students' answers were replied by giving feedback and writing "the facilitative, training aimed educatory answers of metacognition" about the questions.

Table 1. Metacognitive Procedures, 6 Open-Ended Questions and "The Facilitative, Training Aimed Educatory Answers of Metacognition"

Metacognitive procedures	**Open- ended questions asked to the students**	**Facilitative, training aimed educatory answers of metacognition (Experimental treatment for enhancing metacognitive awareness)** ***As a feedback, researchers begin with an approving sentence and then the sentences above continue;***
Knowledge of cognition Regulation of cognition	1. What do you think of doing first when you encounter a new problem (new learning procedure)? Please list them in order.	I want you to read and think about the following and write down your experiences. In order to solve a problem I do the following: - I think about the things that I have learned before - I decide the things that I don't know and plan how to find them. - I choose the important ones, and put them in order - I review the important knowledge - While doing these procedures, I try to find where I am not sufficient to do and try to straighten it.
Regulation of Cognition	2. How do you plan your learning objectives when you are studying?	How to plan: - I revise the sufficiency of the knowledge that I have already learned and read.

		- I complete the parts which are missing from different sources. - I state the solution of the problem or my learning objectives expressly. - I determine and organize the sub-subjects. - During these procedures I question myself about what I have done and how I have done it. - In every step I think about the probabilities and choose according to them - In order to keep my plan going successfully, I use my time effectively.
Knowledge of Cognition	3. What are your learning methods and learning strategies? How and when do you use them?	Learning strategies are plans created by the individual for achieving goals in various mental tasks, such as solving a problem or memorizing information. Using strategies are affected by personal differences so methods and strategies and their uses vary from person to person. If you use your own learning methods and strategies effectively, you can learn about your own learning very well. Find a new learning strategy about one of your learning objectives that will help your learning and write it down.
Regulation of cognition	4. When you are learning or solving a problem what do you do for better learning or a better way of the solution?	For better learning or a better way of the solution I try my best to organize the new knowledge as following; - I distinguish the important knowledge from the others, - I associate the current knowledge with the new ones - I try to pay attention to the details of the important knowledge - I summarize the new learning to check myself. - I try to draw symbols and graphics - I write subtitles - I think of using this new learning in different areas

		During this time control of attention is a very important state. Write down your experiences about your daily life problems, what you do to solve the problem in a better way.
Regulation of cognition	5. How do you control your learning methods and your learning strategies after you finish your study?	After we finish studying we must check our learning methods and our learning strategies, because the important thing is achieving our goals. If we regularly check ourselves towards achieving our goals, we can reach the best results. Accurate monitoring of new learning enables students with effective metacognitive strategies to concentrate on new content and adjust their learning goals. How to evaluate; - I look for effective strategies while I am studying. - I come out and verify the strategies I use - I find similarities in the new subjects and explain the meanings. - I regularly overview the work I have done, to see the important connections. - I ask questions to myself, to be sure whether I understand the subject I have studied. - While I am solving a problem, I reexamine myself if I consider all alternative solutions. - After I finish a task, I look for the easiest way to do it. - I look for the new ways for being more successful. - After I finish studying I summarize what I have learned.
Regulation of cognition	6. When you notice that the things you have learned are incorrect, what is your initial course action?	Realizing and accepting our mistakes is very important for correcting them and achieving success. Being aware of what we do when we make a mistake is also fundamental for being successful.

	For this reason, - When I mix up the things I study, I go back and try to understand it. - I try to reassess all probabilities - I notice the discrepancy, disunity and confusion, I accept the reasonable ways. - I try to find out my mistakes and correct them -I try to find out the required knowledge. - When I don't understand the subject I ask for help from others. - When I don't understand the subject I change the strategies I use.

Students were asked to practice "the facilitative, training aimed educatory answers of metacognition" and write down their experiences during their learning procedures for the first four questions. These procedures helped them to develop and enhance their metacognition.

Procedures

Each of the 63 students who completed the pre-test MAI was offered an opportunity to volunteer for a 3 months metacognitive training (experimental treatment). 30 volunteers subsequently completed treatment through the electronic medium: e-mail. At the end of the treatment both experimental and control group completed the post-test MAI.

During the 3 months metacognitive training, questions were sent to the students two at a time via e-mail, and the students' answers were replied by giving feedback and writing "the facilitative, training aimed educatory answers of metacognition" about the questions. These mails and answers were used as a training programme (experimental treatment for enhancing metacognitive awareness). It took one month to complete the question-answer-reply procedures for two questions. The answers given by the students to the questions that were asked before (the 6 open-ended questions) interpreted according to "the facilitative, training aimed educatory answers of metacognition" which was prepared compatibly with the MAI, Taxonomy of Metacognitive Activities (Meijer, Veenman, & Van Hout-Wolters, 2006) and problem-solving steps. Each of the 6 open-ended questions covers at least one of the components of metacognition which are knowledge of cognition and regulation of cognition and emphasizes the importance of metacognitive awareness. The students thought about their metacognitive skills and assessed both their knowledge of cognition and how to regulate their cognition while answering the questions. Also they were asked to practice "the facilitative, training aimed educatory answers of metacognition" and write down their experiences for the first four questions and this helped them to be

aware of their metacognitive skills, and develop their metacognition. During this treatment the students continued their formal medical education and control group didn't receive any treatment about metacognition. One year later, the MAI was distributed to the participants (n=61) once again to track their state.

Data Analysis

Quantitative analysis: Statistical packages for social sciences (SPSS 11.5) was used for statistical analyses. The quantitative data was collected from MAI. In order to compare two groups in terms of repeated measures, two-way repeated measures analysis of variance (ANOVA) was used. In case of significant differences, Bonferroni corrected repeated measures of ANOVA for each group was performed and for the comparison of groups in terms of percent changes, Bonferroni corrected Mann-Whitney U test was used. Percent change was calculated as the difference of two time point scores divided by the previous time point score and multiplied by 100 [e.g., {(post-test score-pre-test score)/pre-test score}*100]. Mean±standard deviation or median (minimum-maximum) was given as descriptive statistics. $p<.05$ was considered as statistically significant.

Qualitative analysis: The qualitative data was collected from the answers of the students to the 6 open-ended questions. "Content analysis" was used to analyze the qualitative data. "Content analysis" is a method that is used to discover the conceptual explanations and relations between the data. During the content analysis similar data is gathered under a determined concept or theme (for example; "to understand the problem"), and is interpreted by the authors. In this study the answers given by the students to the questions that were asked before (the 6 open-ended questions) interpreted according to "the facilitative, training aimed educatory answers of metacognition".

The students' answers to the first and second questions were organized according to the priority of their answers and under particular themes. After this procedure the answers were compared with "the facilitative, training aimed educatory answers of metacognition". The comparison was done according to the conformity of students' answers and the training aims. The answers to the third question were organized under three main themes without counting the priority of the answers. The answers to the other three questions were organized under particular themes and then they were interpreted according to the training. The second part of the first four questions which consist of the students'experiences during their learning procedures supported and strengthened the interpretations.

RESULTS

Quantitative Results

There were no significant difference between mean pre-test scores of experimental and control groups (p=.964). When the pre-test, post-test and follow up test scores were evaluated, overall group effect, overall time effect and group*time interaction effects were found to be statistically significant (p=.012,

p=.019 and .008, respectively) (Table 2). The clear evidence of significant interaction effect could be seen from Figure 1.

Table 2. Pre-test, post-test and follow up test scores in experimental and control groups

Group/Time	Pre-test	Post-test	Follow up
Control (n=32)	3.71±0.36	4.12±0.39	3.90±0.39
Experimental (n=29)	3.72±0.42	3.67±0.42	3.87±0.47

Numbers represent mean±standard deviation

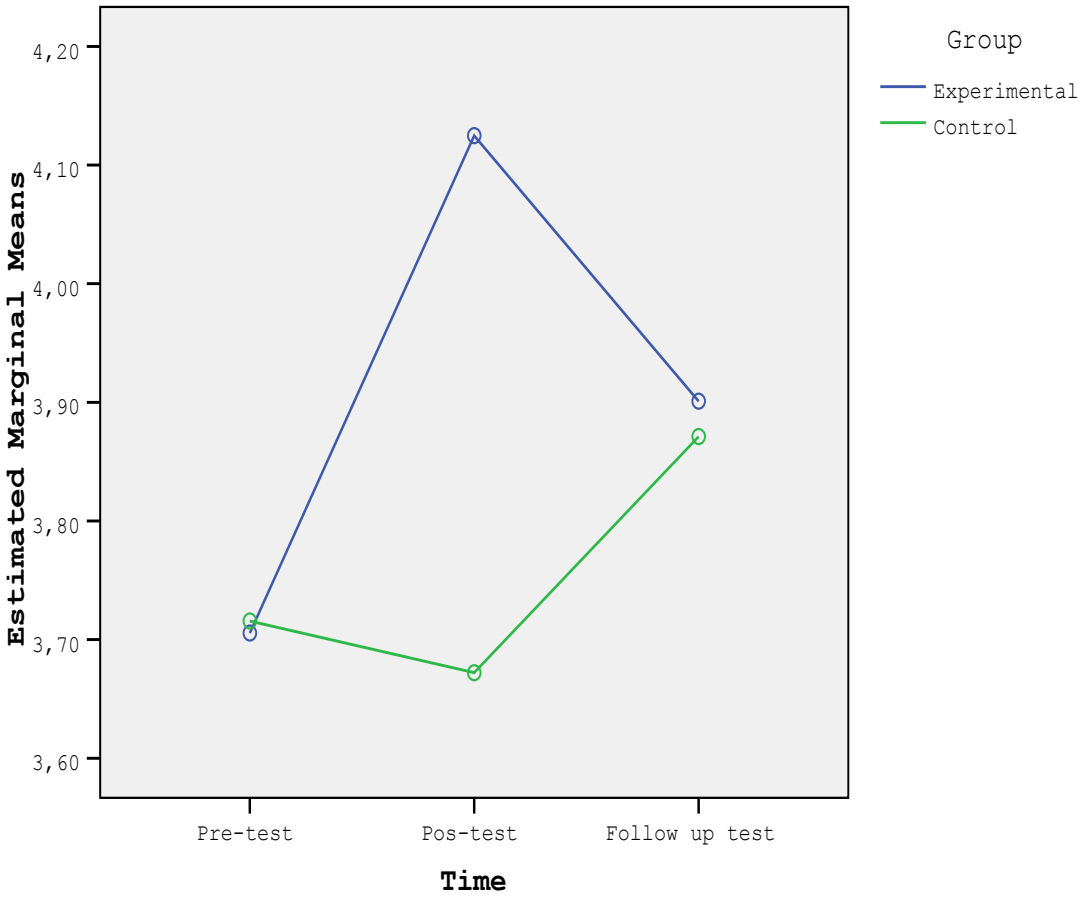

Figure 1. Time Differences in Both Groups

After splitting data for groups and performing Bonferroni corrected repeated measures of ANOVA, the differences of pre-test, post-test and follow up scores

were statistically significant in experimental group (p=.002<.025), but not in control group (p=.215>.025).

When the significant differences in experimental group were examined in detail, pre-test scores were found to be lower than both post-test scores (p=.003) and follow up test scores (p=.043). Although the post-test scores were higher compared to follow up scores, there was no statistically significant difference between post-test and follow up test scores (p=.166). If we could continue to give the metacognitive training after post-test until the follow-up test, we might expect higher follow up test scores.

While there could not be found statistically significant differences in control group, there was a decrease in post test scores compared to pre-test scores and an increase in follow up test scores compared to post-test scores.

In order to compare experimental and control groups, Bonferroni corrected Mann-Whitney U test was performed to examine the percent changes. After analyses, only the percent change scores of pre-test and post-test (p=.004<.017) and that of post-test and follow up test (p=.007<.017) were statistically significant (Table 3).

Table 3. Percent Change Score Comparisons in Groups

Group	Percent		
	change 1	change 2	change 3
Experimental (n=29)	10.88 (-15.15; 61.87)	6.03 (-16.82; 32.24)	-5.06 (-31.84; 33.73)
Control (n=32)	-1.75 (-23.48; 46.43)	4.17 (-23.68; 60)	5.48 (-32.44; 63.51)
P	0.004	0.654	0.007

Percent change 1: [(post-test score-pre-test score)/pre-test score]*100
Percent change 2: [(follow up test score-pre-test score)/pre-test score]*100
Percent change 3: [(follow up test score-post-test score)/post-test score]*100
Cells represent median (minimum; maximum)

When the descriptive statistics were evaluated, the change in experimental group was higher for the percent change of pre-test and post-test scores. This result reinforces the research results demonstrated before (Hartman, 1998; Schellenberg, Negishi, & Egen, 2011; Schraw, 1998) that metacognitive capabilities can be enhanced by training.

Although the difference in magnitude was similar in both groups for the percent change of post-test and follow up test scores, the direction was different. While the follow up test scores were higher in control group compared to post-test

scores, post-test scores were higher in experimental group compared to follow up test scores.

Though the difference between groups in terms of percent change scores of pre-test and follow up test was not statistically significant (p=.654), the change was higher in experimental group (median: 6.03) compared to control group (median: 4.17). We might explain this result with the effect of the metacognitive treatment which was given a year ago.

Qualitative Results

The answers given by the students to the questions that were asked before (the 6 open-ended questions) interpreted according to "the facilitative, training aimed educatory answers of metacognition".

In the first question the students were asked to interrogate their "knowledge of cognition" by reexamining their knowledge that they have learned before, because the theory of constructivism suggests that learners construct knowledge out of their experiences. So experiences and the knowledge which have been learned before are meaningful for the learner. "I think about the things that I have learned before" was written only by two students initially. The students mostly wrote "to understand the problem" which was also important and should be mentioned as the first step in the answers. Except the second step which is "I decide the things that I don't know and plan how to find them", the other steps were not mentioned by the students.

They were asked to interrogate their "regulation of cognition" by choosing, putting in order and reviewing their knowledge. During these processes our aim was to monitor them, to assess their cognitive functions and to develop their metacognitive skills. Planning which is a basic skill of "regulation of cognition" involves the selection of appropriate objectives and strategies and the allocation of resources that affect performance (Schraw & Moshman, 1995). The students were reminded that these skills were important for them to develop their metacognitive skills. Regulatory competence improves performance in a number of ways, including better use of cognitive resources such as attention, better use of strategies, and a greater awareness of comprehension breakdowns (Schraw & Moshman, 1995).

In the first question it was discovered that the students were partly competent in thinking about what to do first when coming upon a new problem. But it was highlighted that being aware of the answers and need to practice them were very important for their development and success. Recent researches indicate that allowing individuals to plan, sequence, and monitor their learning in a way directly improves performance (Hartman, 1998; Schellenberg, Negishi, & Eggen, 2011; Schraw, 1998).

According to the content analysis results of the second question the students were found incompetent in "inquiring sufficient knowledge", "stating the solution expressly" and "determining sub-subjects". The students need more support to be more competent in self-assessment and reflection.

It was understood that the students were better in "thinking about the probabilities" and "using time effectively" than in the other steps of the answer. Seven of the students (30%) mentioned "using time effectively", which is significant for planning. In every step of planning "using time effectively" is very important, especially during learning. A person's allocation of study time is partly controlled by the interplay between two components of metacognition: (a) a person's assessment about the current state of learning for an item and (b) the person's desired degree of learning for the item, which is called a norm of study. If a person sense that his/her learning degree is equal or more than his/her norm of study, he/she terminate the study of one item to move on to another (Dunlosky & Thiede, 1998).

The students were asked in the third question to realize and think about their own learning methods and learning strategies. During this procedure they could evaluate themselves and explicate their learning methods and strategies.

The fourth question asked to the students to reevaluate their own learning process for better learning or a better way of the solution. "The facilitative, training aimed educatory answers of metacognition" for this question provided basis steps, but all the answers of the students were accepted whether they wrote the training information or not. The important thing was to think and evaluate their learning process and to find out a better way. This process helped the students to become aware of their both metacognitive knowledge and metacognitive regulation.

In the fifth question the students were asked to monitor their new learning by evaluating their learning methods and strategies towards achieving their goals. When we reviewed the answers we discovered that although the students didn't mention the steps "I reexamine myself if I consider all alternative solutions" and "I find similarities in the new subjects and explain the meanings", they were partly competent in controlling their learning.

The sixth question was asked to the students to realize and to accept the mistakes they have done, and to be aware of what they should do. According to the students' answers we could say that they were competent in realizing and correcting their mistakes, which were their experiences gained during their monitoring practices.

The students were asked to practice "the facilitative, training aimed educatory answers of metacognition" and write down their experiences during their learning procedures for the first four questions. Table 4 shows some of the quotations they wrote during their practices which strengthened our interpretations of qualitative results. During the treatment we noticed that there was an increase in metacognitive awareness in students' answers.

Table 4. Examples of the Students' Experiences during Their Practices

- "If I have some knowledge about the subject that I will learn, this will motivate me because connecting new knowledge to the old ones will help to learn easier."
- "I tried to realize what I didn't know, and tried to search from other resources."

- "Before starting to study, I planned my studying and resting times."

- "I thought about the learning strategies I have used before and chose the one that I believed would be the best to learn this subject."

- "After I have finished studying, I checked myself by asking what I have learned. "

- "One of my learning objectives at PBL was "causes of fever. I studied fever from different books and notes then I asked myself some questions about the subject and tried to answer them."

- "I realized that when I explicated the subject I have learned to my friends I could easily retain and remember the knowledge."

These sentences, one by one showed that the students' metacognitive skills were developed and enhanced.

DISCUSSION

This is the first study done in medical education about metacognition which is required for medical students as a lifetime learner. The aim of this study is to examine the metacognitive awareness of medical students and to see the impact of metacognitive training on their metacognitive awareness. Mixed method design which involves both quantitative and qualitative methods was used in the study. According to the quantitative results the students who completed the metacognitive training got significantly higher scores from MAI, than the control group after the treatment. The students did some thinking on their learning and thinking procedures and had experiences while practicing during the metacognitive training.

Building metacognitive awareness among learners promotes metacognition which exists, and increases academic success (Schellenberg, Negishi, & Eggen, 2011; Schraw 1998). As the students act on the awareness of their own thinking and learning they tend to learn better (Bransford, Brown, & Cocking, 1999; Schellenberg, Negishi, & Eggen, 2011). According to our results the students can be taught to improve metacognitive proficiency through repeated guided practice. Furthermore when we looked at all the qualitative results we noticed that there was an increase in metacognitive awareness in students' answers during the treatment.

One year later, a follow-up test was performed. According to the results the follow-up scores compared to post-test scores were lower in experimental group, those were higher in control group, and however none of them were found to be statistically significant. On the other hand, though the difference between groups in terms of percent change scores of pre-test and follow-up test was not statistically significant, the change was higher in experimental group compared to control group. We might explain this result with the effect of the metacognitive treatment which was given a year ago. We believed that if we could have continued to give

the metacognitive training until the follow-up test, we might have expected higher follow-up test scores from the experimental group.

Self-assessment of learning depends on both internal and external factors. Internal factors such as metacognition enable students to reflect on their own accomplishments, to monitor their progress while learning, and to evaluate their understanding against other standards of performance[19]. Metacognition enables individuals to better manage their cognitive skills and to determine weaknesses that can be corrected by constructing new cognitive skills (Howard, McGee, Shia, & Hong 2000). Because metacognition often takes the form of an internal dialogue, many students may be unaware of its importance unless the processes are explicitly emphasized by teachers (Bransford, Brown, & Cocking, 1999). Medical students, who are expected to be medical experts, should focus on their capabilities to continuously assess, monitor, and improve their performances (Quirk, 2006).

According to our qualitative results the students needed to develop their planning, reflection and self-assessment skills. These are basic skills for regulation of cognition, and critical to developing medical professionals which are essential to both clinical practice and learning. Metacognitive monitoring and metacognitive control skills which learners actively engage in thinking about their learning and factors that bear on learning could be improved with exercising. The most prominent practice is the use of metacognitive cues in the course of instruction. Some metacognitive instructional practices are; metacognitive prompts (metacognitive cues, questions or checklists that were used by the students during activities such as problem-solving, experimentation, inquiry learning, reading texts, writing reports and reflections, or discussing topics), reflective writing, group discussions of thinking and learning processes and explicit instruction such as explanations and demonstrations by the teacher regarding specific cognitive or metacognitive strategies (Zohara & Barzilaib, 2013). So the significance of metacognition for improving learning and instruction should be considered during the development of curriculum and educational methods.

Knowledge is continuously changing and advancing, and dealing with novelty is an important aspect of patient encounters. In the medical profession, the ability to direct and regulate one's own learning experience is crucial to success. Self-directed learners plan, set goals, organize, self-monitor, and self-evaluate at various points during the process of acquisition. Shokar et al. (2002) showed that the medical students' clinical performance was correlated with their competency in self-directed learning and planning (Shokar, Shokar, Romero, & Bulik, 2002). Doctors who are metacognitively strong are self-directed learners and carry on their competency throughout their lives.

Cutting and Saks (2012) reviewed important principles of learning to determine those most relevant to improving medical student learning, guiding faculty toward more effective teaching, and in designing a curriculum (Cutting & Saks, 2012). The learning principles they believe are most essential, are those that foster deep and durable learning, a goal for all future physicians. One of the principles is "promoting metacognition" (Cutting & Saks, 2012). As the students

with effective metacognitive skills accurately estimate their knowledge in a variety of domains, monitor their on-going learning, update their knowledge, and develop effective plans for new learning, medical educators should focus on the development of the students' metacognitive proficiency during curriculum development of medical schools.

Reflective writing and reading exercises; interactive teaching styles that facilitate reflection, self-assessment and perspective-taking; feedback designed to improve self-assessment as well as performance, and modeling metacognition are teaching strategies that medical school faculty can foster the development of medical expertise by enabling their students to develop metacognitive capabilities (Quirk, 2006). These strategies can be used in PBL which helps students develop self-directed learning skills, reflection and self-assessment besides effective problem-solving skill and intrinsic motivation (Barrows & Tamblyn, 1980; Davis & Harden, 1999). Turan et al (2009) showed that the students in PBL curriculum have higher MAI scores. They conclude that a learner-centered approach is essential to learn those skills that are important for attaining lifelong learning (Turan, Demirel, & Sayek, 2009). Faculty can give feedback to students on their thinking processes or model the process of thinking aloud when reasoning through clinical problems and making clinical decisions during group instruction, at the bedside, for promoting metacognition (Cutting & Saks, 2012).

A medical doctor needs to know what he/she knows and doesn't know, how he/she best learns, how to develop and implement a plan to obtain what he/she needs, and how to monitor his/her success in getting there. Specifically, medical students must develop the abilities to (a) define and prioritize their goals, (b) anticipate and assess their specific needs in relation to the goals, (c) organize (and reorganize) their experiences to meet their needs, (d) define their own and recognize differences in others' perspectives, and (e) continuously monitor their knowledge base, problem solving, and interactions with others (Quirk, 2006). This study was designed to examine the students' learning processes, to interrogate what they do and how they control their learning processes. They thought about their learning and thinking procedures and had experiences while practicing during the metacognitive training. All the things they have done increased their metacognitive awareness.

As limitation, because metacognition is a hardly conceptualized framework, it is hard to form a new training programme for this aim. This new mixed programme needs an eclectic way of rethinking of training programmes. It seemed it was a limitation to use a small sample in the qualitative part of the study. But as we seen in the literature a training programme with medical students couldn't be done with a larger number (Creswell, 2003).

We also need further well-designed studies to justify that "the facilitative, training aimed educatory answers of metacognition" provides a positive effect on the students' metacognitive skills. Further studies should be done periodically to assess the students' metacognitive skills and to see their developments.

CONCLUSION

The results showed that metacognitive capabilities can be enhanced by training which must be continuous to improve metacognitive skills.

In order to help the students learn how to learn and increase metacognitive capabilities following can be done;

- Informing the students about metacognition and life-long learning,
- Helping the educators in realizing and being role-models in terms of the importance of metacognition
- Using educational methods or metacognitive instructional practices to improve metacognitive skills.

It is important, therefore, to evaluate students' metacognitive abilities and target instruction to the development of these key learning strategies. Students with effective metacognitive skills accurately estimate their knowledge in a variety of domains, monitor their on-going learning, update their knowledge, and develop effective plans for new learning.

Future research would need on educational methods to develop students' thinking skills, advancing deep understanding and to improve their metacognitive skills. Also more studies should be done for educators how to teach the various metacognitive skills.

Medical students should continuously assess, monitor, and improve their performances to develop medical professionals which are essential to both clinical practice and learning and they attain lifelong learning which needs metacognitive skills. To determine medical students' metacognitive awareness, a new inventory, specific for medical students could be designed.

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