Exploratory and Confirmatory Factor Analysis of the Metacognition Scale for Primary School Students

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Abstract

The purpose of this study is to develop the Metacognition Scale (MS) which is designed for primary school students. The sample of the study consisted of 426 primary school students in Izmir, Turkey. In order to examine the construct validity of the MS, exploratory factor analysis and confirmatory factor analysis were performed. For the validity of the MI, corrected item-total correlations were used. The corrected item-total correlations ranged from .35 to .65. In addition, t-tests between items' means of upper 27% and lower 27% points were compared. For each factor and each item, the differences between mean scores of upper 27% and lover 27% groups are significant. Finally, Cronbach alpha correlation coefficients were used. The internal consistency of the MS is .96 for the entire scale. The MS has eight scales: declarative knowledge, procedural knowledge and conditional knowledge, planning, self-control, cognitive strategies, self assessment and self monitoring. According to these findings, the MS is appropriate for researchers or teachers whose aim is to measure his/her students' metacognitive awareness and metacognitive abilities.

Key Words

Metacognition, Learning, Exploratory Factor Analysis, Confirmatory Factor Analysis.

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New approaches towards learning have been suggested and the factors effective on the success and failure of the students have been studied since the 1970s. According to these research studies, the factors resulting in student failure are that students do not adopt a specific learning strategy (Feitler & Hellekson, 1993); that they find it difficult to use strategies appropriate for a specific task; and that they prefer ineffective strategies and plans when encountered with new and complex tasks (Kirby & Ashman, 1984). For instance, students who cannot understand the main intention and what to do when asking a question may fail in asking high-quality questions (Açıkgöz, 2002). In addition, unawareness of one's own learning processes and lacking required skills to control such processes can be listed as some of the other barriers before the successful learning and high performance (Gunstone, 1994). Therefore, it is suggested that -as well as cognitive processes- a metacognition emphasizing awareness of these processes may be effective on meaningful learning and the transfer of the learned items to the long term memory (Georghiades, 2004).

Flavell (1987) described metacognition as knowledge and cognition about cognitive objects, that is anything about cognitive. The fact that research giving a place to metacognition in psychology, health and education have increased as of the middle of the 1970s have brought about new definitions. Metacognition refers to the knowledge, awareness and control of one's own learning (Baird, 1990; Gunstone & Mitchell, 1998). Planning learning, management of understanding, or inferring and self-evaluation strategies are other definitions of metacognition (Açıkgöz, 2000). According to the framework developed by Nelson and Narens (1990), metamemory is constantly monitoring the memory system retrospectively (e.g., confidence judgment) and prospectively. After the goal of study has been determined, the person makes a decision about how to attain that goal (i.e., formulates a plan). This has several parts, involving several kinds of monitoring judgments that need to be distinguished. Ease-of-learning (EOL) judgments are predictions about what will be easy/difficult to learn, either in terms of which items will be easiest or in terms of which strategies will make learning easiest (Nelson & Narens, 1990). For example, when a student receives a text to study, he or she will analyze and judge its difficulty a priori (EOL judgment) and, based on this judgment, allocate study time and select the kind of strategy to approach the material (Carvalho &Yuza-

wa, 2001). Subsequently, after the study, the student can judge whether he or she has studied well or long enough (JOL judgment) and, based on this second judgment, decide whether to terminate the study section or to consider a change in the strategies to approach the material to be studied. Later on, at the exam, if the student does not remember the answer for a given question but still has the feeling that he or she knows it or at least that it should be known (FOK judgment), it is based on this third judgment that the student decides whether he or she will keep trying to remember the currently nonrecallable answer (Carvalho &Yuzawa, 2001).

Metacognition is divided into two sub-components as knowledge of cognition and regulation of cognition (Nietfeld, Cao, & Osborne, 2005; Pintrich, 2002; Schraw & Moshman, 1995). Although classification studies were carried out except for taxonomy of knowledge of two-factor cognition and arrangement of cognition, these studies received little support (Akın, Abacı, & Çetin, 2007). The first of these components, the knowledge of cognition involves knowledge about cognition in general, as well as awareness of and knowledge about one's own cognition (Pintrich, 2002; Schraw & Moshman, 1995; Thomas & Mee, 2005). The knowledge of cognition differentiates into declarative, procedural, and conditional knowledge categories (Jacobs, & Paris, 1987). An individual's declarative metacognitive knowledge includes their conceptions, and also their beliefs of task structures, their cognitive goals, and their own personal abilities (Schraw, 1998; Schraw & Moshman, 1995; Schraw, Crippen, & Hartley, 2006). Any student who is aware of and can state making link between issues with daily life is an example of declarative knowledge. Procedural metacognitive knowledge includes information about how they perform cognitive tasks (Jacobs & Paris, 1987; Pintrich, 2002; Schraw, 1998; Schraw et al., 2006; Sperling, Howard, Staley, & Murphy, 2002; Thomas & Mee, 2005). Any students who can state the problem-solving procedure has procedural metacognitive knowledge. Conditional metacognitive knowledge includes their understanding of both the value and the limitations of their procedural metacognitive knowledge and knowing when, how, and why procedures should be used (Jacobs & Paris, 1987; Schraw, 1998; Schraw et al., 2006; Thomas & McRobbie, 2001; Thomas & Mee, 2005). The opinion 'I examine the topic, if it is so easy that I can study on I try to identify it with my daily life but if I find the topic too difficult to learn, then

I give up studying.' can be given as an example to conditional knowledge. Hence, despite metacognitive knowledge being nominally dissectible into three distinct categories, interaction between these categories is evident and necessary (Thomas & McRobbie, 2001).

Regulation of cognition includes planning, monitoring, and evaluation skills (Deonaraine, 1998; Jacobs & Paris, 1987; Schraw, 1998; Schraw & Moshman, 1995). Planning involves the selection of appropriate strategies and allocation of resources that effect performance (Schraw & Moshman, 1995). If a student tries to understand the aims of the questions before s/he begins the exam that means s/he is making a planning. Monitoring refers to one's awareness of comprehension and task performance while in the process of performing a specific task (Nietfeld et al., 2005) and it is controlling at regular intervals the process to see if the material heard or read is understood (Candan, 2005). The opinion "I ask myself if I am sure or not to be sure if I have really learned" is an example to self-monitoring. Evaluation refers to appraising the products and regulatory process of one's learning (Schraw & Moshman, 1995). For example, if a student thinks that he has controlled his answers and is successful in all parts after he solves a problem that means he evaluates himself.

Gauld (1986) suggested that students should realize their own cognitive structures and adopt metacognitive skills to think on such structures. Only by this way they can restructure the knowledge in the right manner. In the study he examined the use of analogy (1994), Mason observed a superficial relationship between the students' level of understanding the analogy and their metacognitive awareness related to educational purpose and analogy use.

The Measurement of Metacognition

It has been suggested that, if students' metacognition can be improved, then it should be possible to improve their learning outcomes (Thomas, 2003). Studies showed that by improving metacognition students understand their own ideas as well as those expressed by other students and be aware of how his/her understanding progresses in order to achieve better understanding of taught material (Beeth, 1998; Blank, 2000; Hennessey, 1993; Georghiades, 2004; Thomas & McRobbie, 2001; Yürük, 2005). Therefore, some studies have aimed to measure metacognition whether it is effective on students learning or not, others have concentrated on validity and reliability of the instruments for assessing metacognition. Structured interview, stimulated recall, and self-reports have been used to measure metacognition.

Each of the methods that measures metacognition has advantages and disadvantages. Interviews and other rich data sources, such as journals and open-ended responses, are problematic because of the relatively lengthy time to administer and time-consuming process of data analysis (Sperling et al., 2002). Self-report inventories as measures of metacognitive processing are easily administered and scored, which makes them useful large-scale assessment tools for determining which learners may need interventions in metacognition (Sperling et al., 2002). An instrument by Schraw and Dennison (1994)'s Metacognitive Awareness Inventory has two components as knowledge of cognition and regulation of cognition. Sperling et al. (2002) developed the Jr. MAI, appropriate for assessing metacognition in children in grades 3–9. Researchers gained a structure similar to factor structure gained as knowledge and arrangement of cognition in the study of Schraw & Dennison. O'Neil & Abedi (1996) developed State Metacognitive Inventory composed of four subscales: awareness, cognitive strategy, planning, and self-checking.

In Turkey, Çetinkaya and Erktin (2002) developed an inventory to measure metacognition. The Metacognition Inventory is appropriate for 6th grade students and has four subscales: evaluation, self-checking, awareness, and cognitive strategies. Akın et al. (2007) investigated the validity and reliability of the Turkish Version of the Metacognitive Awareness Inventory originally developed by Schraw and Dennison (1994). Exploratory factor analysis has demonstrated that the items loaded on eight factors under the knowledge of cognition and regulation of cognition dimensions. These eight factors were; declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, information management, debugging, and evaluation (Akın et al., 2007).

As a result, one of the factors considered to be efficient on learning is metacognition. Metacognitive awareness and skills of students should be taken into account so that their learning processes can be improved. So, students can know their cognitive structures, monitor and control them, and make an evaluation about learning. When this field is analyzed at national level, the scales developed and the studies conducted to develop and evaluate metacognition seem to be not enough. The studies for improving and evaluating metacognition that is very significant in permanent and meaningful learning should be increased. When the components put forward with metacognition are considered, it comes out that is needed to measure metacognition. Therefore, the aim of this study is to develop a measurement device that measures metacognition awareness and skills of primary students.

Method

After the necessary permissions were obtained from the Provincial Directorate for National Education in the spring term of 2007-2008 academic year, the study was carried out on 426 primary school students from 8 schools by way of random sampling. 52% of the students were female (n=221) and 48% of them were male (n=205). 34% of them were 6th graders (n=144), 36% of them 7th graders (n=153), and 30% of them 8th graders (n=129) students. The schools in the sampling were visited by researchers and students were met in person.

Instrument

While creating the items of the Metacognition Scale, the previous research that have focused on the topic were reviewed (e.g., Akın et al., 2007; O'Neil & Abedi, 1996; Schraw & Dennison, 1994; Sperling et al., 2002) and a 40-items scale was created. This new instrument was developed by following the Metacognition Scale, consisting of 4-point Likert scaling: 'every time' (4 points), 'often' (3 points), 'sometimes' (2 points), 'never' (1 point).

Results

Before the factor analysis, appropriateness of the data for the factor analysis was analyzed via Kaiser-Meyer-Olkin (KMO) and Barlett Sphericity test. KMO value of the scale was found to be 0.95. This shows that data are appropriate for the factor analysis (Leech, Barrett and Morgan, 2005). Barlett's Sphericity test was made to verify that the data have multi-variable normal distribution (Tavşancıl, 2002).

The initial solution revealed six subscales with an eigenvalue greater than 1. When the items in subscales were analyzed, a difficulty occurred in giving a name to the subscales coming out. Thus, like in the study of Akın et al., (2007), the scale was considered to have 8 subscales and subscale structure was limited to 8 and reanalyzed. After using varimax rotation, the loadings for each item was examined. Ten items had a high loading on more than one subscale. Therefore, these eight items were eliminated and varimax rotation was maintained and replicated. Loadings of less than 0.30, a commonly used of cut-off, were eliminated. The final solution had eight subscales with an eigenvalue greater than 1. All the eight subscales combined explained 71.36 %of the variance.

Confirmatory factor analysis is conducted to analyze at which level a pre-determined or designed structure is confirmed by the collected data (Büyüköztürk et al., 2004). Through LISREL 8.51 confirmatory factor analysis, the items for each subscale of metacognition were examined for convergent validity and construct validity. Types of goodness-of-fit measures are: χ^2 =1194, 83 (SD=377, p<0.000), goodness of fit index (GFI) =0.84, normed fit index (NFI) = 0.85, root mean square residual (RMSEA) =0.07, adjusted goodness of fit index (AGFI) = 0.80, root mean square residual (RMR) = 0.05. Results indicated that there is an appreciable relationship between the error covariance of item 26 and 27; and 27 and 28. In this context, it is decided to test the error correlations which are observed among the items that take place under the same factor (latent variable) in the scale, by adding them to model, and to perform CFA again. Types of goodness-of-fit measures for the second CFA are χ^2=1131.31 (DF=375, p<0.00000), RMSEA=0.04, GFI=0.85, NFI=0.87, RMSEA=0.04, AGFI=0.81, RMR=0.05. All of the t-values of items showed statistical significance at the 0.05 level, indicating that all of those five items within each scale were highly correlated with each other and, therefore, revealed convergent validity. Another evaluation tool is analyzing whether the structure has a RMSEA of 0.5 or less (Yurdugül, 2006). Taking into consideration the fact that a GFI, AGFI, CFI or NFI value close to 0.90 refers to perfect compliance (Hair, Anderson, Tahtam and Black, 1998), it can be concluded that eight-factor model complies with the model on the basis of these tools. These values showed that the model had a highly satisfactory fit.

After confirmatory factor analysis, the differences between mean scores of the upper 27% and lover 27% were examined for each item. t test results showed significant differences between each item's means of the upper 27% and lower 27% points. All corrected item-total correlations were ranging from 0.49 to 0.81. To establish that each scale has satisfactory internal consistency, Cronbach alpha coefficient was calculated. The internal consistency of Metacognition Scale is 0.96. Metacognition Scale has eight subscales: declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, controlling, cognitive strategies, and evaluation. In the final scale there are 30 articles and the lowest point that can be taken is 30, the highest point is 120. Answering process of the scale lasts for 15-20 minutes.

Discussion

General evaluation of the Metacognition Scale (MS) shows that it has two main components of knowledge of cognition and knowledge of regulation and many dimensions under these two components. The factors covered by the component knowledge of cognition are declarative knowledge, procedural knowledge and conditional knowledge. Knowledge of regulation component, on the other hand, includes planning, self-control, cognitive strategies, self-evaluation and self-monitoring factors. This structure complies with the two-component structure suggested by the other researchers to explain the concept of metacognition (Brown, 1987; Flavell, 1987; Jacobs and Paris, 1987).

The MS is of a structure that a researcher or teacher wishing to measure metacognitive awareness and skills of elementary level students can use easily. Moreover, it is seen suitable for experimental researches to be made in metacognition at primary level and for researches on variables about metacognition like self-efficacy and motivation. However, instead of using only one measurement device, it is suggested that triangulation should be made using of methods like interview and observation supporting these measurements qualitatively.

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	BİLİŞ ÜSTÜ ÖLÇEĞİ	Hiç	Bazen	Sık sık	Her zaman
1	Bir soruyu cevaplarken, nasıl yaptığımı kontrol ederim.	( )	( )	( )	( )
2	Soruları cevaplarken doğru yapıp yapmadığımı kontrol ederim.	( )	( )	( )	( )
3	Kafamdaki bilgileri kolay hatırlayabileceğim bir şekilde düzenlerim.	( )	( )	( )	( )
4	Öğretmenin benden ne öğrenmemi beklediğini bilirim.	( )	( )	( )	( )
5	Bir konuyu anlayıp anlamadığımı bilirim.	( )	( )	( )	( )
6	Sınavlarda soruları cevaplamak için gerekli olan süreyi bilir ve kendimi ona göre ayarlarım.	( )	( )	( )	( )
7	Ders çalışırken hangi stratejileri kullandığımı bilirim.	( )	( )	( )	( )
8	Hangi düşünme biçimini, ne zaman kullanacağımı bilirim.	( )	( )	( )	( )
9	Sınavlarda gerek görürsem, düşünüş ve çözüm yollarımı değiştiririm.	( )	( )	( )	( )
10	Bir sınavda soruları çözebilmek için belirli yöntemler kullandığımın farkındayım.	( )	( )	( )	( )
11	Bir konuyu öğrenirken kullandığım stratejilerin ne kadar işe yaradığını bilirim.	( )	( )	( )	( )
12	Bir işi yaparken hatalıysam, geri dönerek hatamı düzeltirim.	( )	( )	( )	( )
13	Bir işi tamamladığımda amaçlarıma ne kadar ulaşabildiğimi sorarım.	( )	( )	( )	( )
14	Öğrendiğim konunun günlük yaşamımdaki yerini düşünürüm.	( )	( )	( )	( )
15	Bir konuyu öğrenmeden önce kendime o konuyla ilgili sorular sorarım.	( )	( )	( )	( )
16	Daha iyi öğrenip, öğrenememem bana bağlıdır.	( )	( )	( )	( )
17	Bir problemle karşılaştığımda bir sürü çözüm yolu düşünür, en iyisini seçerim.	( )	( )	( )	( )
18	Çalışırken hangi yöntemleri kullandığımın farkındayım.	( )	( )	( )	( )
19	Bir konuyu öğrenirken ne kadar zamana ihtiyacım olacağını planlarım.	( )	( )	( )	( )
20	Bir sınavdaki başarımı doğru olarak tahmin edebilirim.	( )	( )	( )	( )

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21	Bir bilginin benim için önemli olup olmadığını anlar, dikkatimi ona yoğunlaştırırım.	( )	( )	( )	( )
22	Çalışmayı bitirdiğimde, öğrenebileceğim kadar öğrenip, öğrenmediğimi anlamaya çalışırım.	( )	( )	( )	( )
23	Tam olarak anlamadığım konuyu tekrar ederim.	( )	( )	( )	( )
24	Kafam karıştığı zaman durur ve tekrar okurum.	( )	( )	( )	( )
25	Sınav sorularını çözmek için birden fazla yol denemeye çalışırım.	( )	( )	( )	( )
26	Sınavda soruları cevaplarken, nasıl düşündüğümün farkındayım.	( )	( )	( )	( )
27	Duruma bağlı olarak farklı öğrenme yolları kullanırım.	( )	( )	( )	( )
28	Bir soruyu çözdükten sonra kendime, daha kolay bir çözüm yolu olup olmadığını sorarım.	( )	( )	( )	( )
29	Kendime düzenli olarak amaçlarıma ne kadar ulaşabildiğimi sorarım.	( )	( )	( )	( )
30	Sınav sorularındaki ana düşünceleri bulmaya çalışırım.	( )	( )	( )	( )

Ek-1. Madde Örtük Değişken ve Örtük Değişkenler Arasındaki Standardize Edilmiş Kat Sayıları Gösteren Path Diyagramı