Assessment of Metacognition and its Relationship with Reading Comprehension, Achievement, and Aptitude

Pelin Çetinkaya and Emine Erktin

Abstract

The main purpose of the present study was to construct an assessment tool for metacognition for Turkish regular and gifted preadolescents. The study was composed of two phases. In the first phase, a metacognition inventory was developed. The inventory, which consisted of four subscales, namely evaluation, self-checking, awareness, and cognitive strategies, was found to have high internal consistency and adequate construct validity. In the second phase of the study, correlations of metacognition with reading comprehension, achievement, and aptitude were tapped. The results showed that the awareness and cognitive strategies subscales of the inventory were significantly and positively correlated with reading comprehension. Self-checking and evaluation subscales of the inventory were significantly and positively correlated with science course grades of the gifted students.

Key-words: Metacognition, assessment of metacognition, reading comprehension, achievement, aptitude

The concept of metacognition has recently become a popular area in education. Researchers and educators are deeply concerned about the type and levels of knowledge children are acquiring in schools. Passive transmission-reception of information and memorization of facts are not the kinds of learning that will be required for success in the future. The students will be expected to think critically about what they have heard and read, identify relationships among ideas, engage in complex decision-making (King, 1990), and monitor their own thought processes. Studies explicitly show that metacognitive skills play an important role in effective learning that leads to academic success (Flavell, 1985; Klein, 1998; Swanson, 1992; Zimmerman and Martinez-Pons, 1990).

In order to understand metacognitive processes better, individual differences in metacognitive activities should be examined. Bonds and Bonds (1992) claim that there is a relationship between reading and metacognition because the good readers begin reading strategically and use words as sources for information, whereas poor readers rely more heavily on information from contextual sources to gain meaning. According to Guthrie (1982), metacognition helps readers adjust their reading behaviour to the characteristics of the text, which results in better reading and more comprehension (Bonds and Bonds, 1992).

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In addition to this, studies show that academically achieving students are better on metacognitive measures (Klein, 1998; Swanson, 1992; Zimmerman and Martinez-Pons, 1990). For example, J. T. Guthrie (1982) states that better-than-average fifth-grade readers demonstrate metacognitive skills whereas worse-than-average readers show metacognitive deficits by failing to recognize that they don't understand (Bonds and Bonds, 1992).

Metacognition has also been linked to intelligence. Although Schraw and Dennison (1994) claim that metacognition is separable from other cognitive constraints, like aptitude and intelligence quotient (IQ), many other researchers come up with opposite findings. According to Swanson (1990) metacognition is related to a number of cognitive abilities and aptitudes. Related to this, in recent years, researchers have investigated gifted students' use of metacognition (Manning and Glasner, 1996). Zimmerman and Martinez-Pons (1986) compared gifted and non-gifted children's use of self-regulated learning strategies. They confirmed that gifted students regularly used these strategies more frequently and skillfully than non-gifted ones. In another study, Schraw and Graham (1997) concluded that gifted learners use more strategies flexibly, and may benefit more than other students do from scaffold instruction intended to improve self-regulation. Again the same researchers state that metacognitive knowledge appears to develop earlier in gifted than non-gifted students. Metacognitive control (especially planning and monitoring) also shows more advanced growth in gifted than non-gifted students.

Flavell (1985) states that if the metacognitive skills are of great importance, then they should be taught to children directly. Currently, many skills are taught at schools in a manner in which they will be tested rather than how the skills would be used in life (Travis, 1996). As a result, students begin to study- in fact memorize- to get grades rather than for the need and desire of acquiring the knowledge and skills they will use in the future. The evaluation should include description of how students plan, monitor, and evaluate, including self-discussion of misconceptions and errors as well as strategies (Baron, 1987). Instead of measuring knowledge, educators could identify the students' level of metacognition through assessing metacognition. However, only a few researchers have come up with tools or techniques for assessing metacognition (Klein, 1998; O'Neil and Abedi, 1996; Schraw and Dennison, 1994).

The present study aimed to construct a tool to effectively assess metacognition for Turkish children since there are no or few Turkish assessment tools for metacognition, and to tap its correlations with reading comprehension, Turkish, mathematics and science achievement, and aptitude.

Study 1

Method

Inventory Construction

In developing items for the metacognition inventory, initially empirical studies of metacognition and the standardized instruments for assessing metacognition were reviewed (O'Neil and Abedi, 1996; Schraw and Dennison, 1994).

First, the domains of metacognitive skills were identified based on previous instruments (O'Neil and Abedi, 1996; Schraw and Dennison, 1994). Then, items related to these domains were constructed. The first form of the inventory was comprised of these subscales: cognitive strategies, planning, monitoring, self-checking, debugging, evaluation, awareness, information management strategies, and procedural, conditional, and declarative knowledge. Items of the instrument were Likert-type, all scaled from 1 to 4 (1=Never, 4=Always). The first form was a self-report inventory with a total of 53 items.

In order to choose the best items, several steps were taken. A form for expert evaluation of the items was developed, which could also be used in order to obtain initial construct validity evidence. Seven experts, who were teachers in the Department of Secondary School Science and Mathematics Education and the Department of Educational Sciences at Boğaziçi University, were asked to determine which items belonged to which subscales and to what extent, by rating the items from 1 to 3. The mean rating for each question was calculated. The ones with the highest value were taken into consideration.

The results showed that the "information management strategy" domain had very low ratings and was associated with the "cognitive strategies" domain. The "information management strategy" was considered as a component of the "cognitive strategies" domain, rather than being a separate domain.

As a second step, 60 students consisting of 39 males and 21 females, from the Department of Secondary School Science and Mathematics Education of the Faculty of Education of Boğaziçi University, who had recently taken a measurement and evaluation course were administered the inventory. The reliability analysis indicated reasonable initial internal consistency for the entire scale. The alpha coefficient was found to be .91. Items with item-total correlation coefficients lower than .15 were eliminated from each domain. Items were then reviewed for face validity. Wordings and grammatical structures were improved. The inventory, after undergoing these processes, ended up with 32 questions.

Reliability and Validity of the Inventory

In order to measure the reliability and validity of the metacognition inventory, a pilot study was conducted.

Sample. The study was conducted in a private school in İstanbul. The school was selected on the basis of convenient sampling. The participants were 111 sixth grade students, consisting of 60 males and 51 females. The sample included two groups of students. One group consisted of those who had taken a preparatory class to learn English and were a year older. The other group was the ones who did not attend a preparatory class. The mean age was 12. The sample represented high to middle socio-economic (SES) levels.

Results. For the internal consistency of the scale, Cronbach alpha and item-total correlation coefficients were computed. The study done with the pilot sample showed an alpha coefficient of .87.

For the construct validity, the emphasis was on the judgemental ratings. As further evidence for validity, factor analysis was used. Factors of the pilot data were compared with the domains obtained from the judgemental ratings. Principal component analysis with varimax rotation was applied on the domain items to see how items grouped together under each domain. However this analysis indicates that the differential validity of the domains was weak. Multiple factors emerged on several domains. The results led to further questions for the dimensionality of the metacognition inventory.

Table 1. Factor Loadings of the Items of the Metacognition Inventory

Questions	Factors			
	1	2	3	4
Q1	,199	8,091E-02	9,984E-02	,475
Q2	,558	,148	,202	-8,329E-02
Q3	-,188	,219	,171	,512
Q4	,284	,240	,315	-,133
Q5	,107	,322	,109	,363
Q6	,172	,344	9,240E-02	,272
Q7	-,133	,292	,463	5,841E-02
Q8	,553	,327	,158	-,290
Q9	,163	,507	3,523E-02	,233
Q10	-7,143E-02	,522	8,595E-02	2,873E-02
Q11	,165	,525	,157	,109
Q12	,136	,572	7,672E-02	,279
Q13	,371	,369	,111	,102
Q14	3,895E-02	,151	,426	,183
Q15	5,409E-02	,622	,204	-,225
Q16	,188	,424	7,332E-02	,122
Q17	6,744E-02	8,025E-02	,550	9,999E-02
Q18	,268	,103	,542	2,320E-02
Q19	5,428E-02	,272	1,384E-02	9,414E-02
Q20	,253	-7,542E-02	,500	,235
Q21	,165	,120	,176	,596
Q22	,444	7,527E-02	,212	4,756E-02
Q23	,104	,329	-,238	,365
Q24	,542	8,074E-02	,155	6,167E-02
Q25	,190	,121	,309	,446
Q26	,286	2,999E-02	,410	,110
Q27	3,039E-02	9,308E-02	,396	,295
Q28	,328	,190	,151	,114
Q29	,415	-3,383E-02	,108	,309
Q30	,435	,123	8,415E-02	,387
Q31	,681	-,133	-,185	,254
Q32	,440	,220	-,253	,132

In order to find the dimensions of the metacognition inventory, another factor analysis with the data from the 346 students- a total of pilot, and main study participants- was performed. Exploratory factor analysis showed 12 factors with Eigen

values greater than 1. The scree plot showed that four factors existed. After the scree plot, confirmatory factor analysis for four factors was performed. These were named self-checking (Q2 I check my work while I am answering a question), awareness (Q12 I know what kind of information is most important to learn), cognitive strategy (Q5 I ask myself if the problems in the test are related to what I already know), and evaluation (Q20 I use multiple thinking techniques/strategies to solve the test questions and choose the best one). Each item with all its factor loading values is presented in Table 1.

Study 2

Method

Sample

The participants were all sixth grade students of a private primary school in İstanbul. The school was selected based on convenient sampling. There were a total of 206 students and all were from middle-high and high SES. There were 91 female and 115 male students ranging between 11 and 14.

To identify the relationship between metacognition and aptitude, all the gifted sixth graders were selected from a school for the gifted in İstanbul. The children were from low SES families. There were a total of 29 gifted sixth grade students who participated in the study. There were 20 male and 9 female children. Their ages ranged between 11 and 13.

Instrumentation

Reading comprehension test. A reading comprehension test was developed by the researchers and a clinical psychology graduate student as part of the program on the development of human cognitive capacity. Items of the initial version of the reading comprehension test were selected from several test books prepared for the same age level children as the target population of the present study. The test included 100 multiple-choice questions.

The reliability study was done with 400 sixth grade students of a private school in İstanbul. The school was selected based on convenient sampling. The mean age was 12. The sample represented high to middle SES levels. The results showed an alpha coefficient of .93.

Achievement. As an operational definition for achievement, students' average grades in Turkish, mathematics, and science courses obtained by the end of the academic year were used.

Procedures

A short meeting was held with the principal of the school before the implementation. The aim of the study and the application procedure were discussed. The metacognition inventory and reading comprehension test were given to students during their regularly scheduled class hours. Both instruments were administered by classroom teachers. The reading comprehension test was applied in one class hour because previous

administration of the test showed that, it takes approximately one class hour for children to finish answering all the questions.

Results

Although the analysis of correlation between metacognition and reading comprehension showed a non-significant result (**r**= .13; **p**=. 058), it was found that the results showed that the awareness and cognitive strategy subscales were significantly correlated with reading comprehension (**r**=. 16; **p**=. 022 and **r**=. 16; **p**=. 019, respectively) (See Table 2).

Table 2. Correlation between the Subscales of the Metacognition Inventory and Students' Reading Comprehension Test Scores

Subscales	r	p
Self-checking	-.012	.867
Awareness	.160	.022
Cognitive strategies	.163	.019

No significant correlations were found between the metacognition scores and the achievement in the Turkish, science, and mathematics courses (**r**=.08; **p**=.067, **r**=.03; **p**=.37 and **r**=.008; **p**=.65, respectively) (See Table 3).

Table 3. Correlation between Students' Turkish, Maths, and Science Average Course Grades and Their Metacognition Inventory Scores

Course grades	r	p
Turkish	.0798	.067
Mathematics	.0322	.375
Science	.0080	.650

The correlation between general metacognition inventory scores and the course grades of the gifted sample was non-significant (See Table 4), but the two subscales of the inventory, self-checking and evaluation were significantly correlated with science course grades for the gifted (**r**=.420; **p**=.023 and **r**=.415; **p**=.025, respectively).

Table 4. Correlation between Gifted Students' Turkish, Maths, and Science Average Course Grades and Their Metacognition Inventory Scores

Course grades	r	p
Turkish	-.068	.714
Mathematics	-.070	.673
Science	.312	.092

Discussion

The present study focused on developing a reliable and valid inventory for measuring metacognition. The relationship of metacognition with reading comprehension, achievement, and aptitude were tested by using the current inventory. This was also a study for the investigation of the validity. The results of the study indicated that metacognition can be assessed directly and explicitly. Results indicated a relationship between metacognition and comprehension. However, not enough evidence was found for correlations with achievement and aptitude.

Metacognition is becoming important for educators and researchers as a significant factor in academic success. Many studies show that students who use metacognitive skills are more successful compared to the ones who do not. In order to teach them these skills, educators should identify the students' level of metacognition, which is only possible by assessing metacognition (Das, Naglieri, and Kirby, 1994; Flavell, 1985; Klein, 1998; Swanson, 1992; Zimmerman and Martinez-Pons, 1990). A literature review shows that very few standardized measures of metacognition exist. So the present study mainly focused on developing a metacognition inventory for Turkish pre-adolescents. The findings of this study provided support for the internal consistency and validity of the Metacognition Inventory.

The research done about the relationship between metacognition and reading comprehension showed that good readers use metacognitive strategies and skills more effectively than poor readers do. Poor readers fail to understand that they do not understand, whereas good readers use comprehension monitoring to check whether the reading material is understood or not (Flavell, 1985; Guthrie, 1982, and Hillerich, 1990, as cited in Bonds and Bonds, 1992; Woolfolk, 1993). One possible explanation for the present findings may be that metacognitive knowledge is not necessarily statable or conscious (Brown, 1987, cited in Schraw and Graham, 1997; Butler and Winne, 1995). That is, children may apply their knowledge about their own thinking without being able to express that knowledge (Montgomery, 1992).

Related to this, children who have previously taken a reading comprehension test could be using some or all of the metacognitive skills presented in the metacognition inventory. However, they might not know that they were using these strategies or skills, so they have failed to answer the questions of the inventory accordingly.

In addition to this, with reference to the second research question, although the results of the present study were non-significant, they show that metacognition is more related with reading comprehension (**p**= .058) and Turkish (**p**= .255). These findings are in line with the study of Osman and Hannafin (1992) who stated that a key component of metacognition- cognitive monitoring- is most commonly associated with reading comprehension. The findings also show that the awareness and cognitive strategy subscales of the metacognition inventory are significantly correlated with reading comprehension (**p**= .022 and **p**= .019, respectively). Also for the gifted sample, the self-checking and evaluation subscales of the inventory are significantly correlated with science course grades (**p**=.023 and **p**=.025, respectively). A possible explanation might be that metacognitive skills are used more frequently and more effectively in verbal tasks rather than numerical or even scientific tasks.

As for the last research question about the correlation between metacognition and aptitude, the results showed no clear advantages of the gifted children over the other ones. Although the results were non-significant, they are not in contradiction with the findings of other research studies. The literature also shows contradictory findings. For example, Schraw and Dennison (1994) claim that metacognition is separable from other cognitive constraints, like aptitude and IQ, whereas according to Swanson (1990) metacognition is related to a number of cognitive abilities and aptitudes. The present study supports the findings that aptitude is not related to metacognition.

It can be concluded that, even though more intelligent children may develop more sophisticated attributions over time (Alexander and Schwanenflugel, 1996), their ability to use this information may be more related to other individual differences rather than intelligence, such as knowledge base familiarity. Children working with familiar tasks might not access metacognitive knowledge because the task itself drives the strategy use. The literature review confirms that gifted children have superiority in their declarative metacognitive knowledge compared to non-gifted children.

Related to this, we may conclude that it is essential to differentiate the types of metacognitive knowledge being measured in studies done with the gifted. These findings highlight the risk of viewing metacogniton as an indissociable process. The researchers, educators, and teachers should be aware of the diversity of the relationship between differing aspects of metacognition and intelligence.

In sum, findings of the present study provide significant information about the concept of metacognition, and its assessment. The review of literature indicates the need for reliable, validated, and theoretically grounded measures in metacognition. The results showed that the present inventory is an internally consistent and partially valid tool for measuring metacognition.

The sample size of the gifted students for the study of the relationship between metacognition and aptitude was rather small. This may be a limitation of the generalizability of the study's findings.

Another limitation in this study might be the truncated range. The scores of the regular and the gifted sixth grade students did not include all the possible scores that could have been obtained in the measures.

In the present study, the only criteria of the achievement of the children were their course grades. These grades may not be a valid indicator of true achievement.

Finally, the present inventory is a self-report assessment tool. In order to monitor metacognition better, a variety of measures are needed. An example to this might be the teacher ratings for children's metacognitive skills.

The present sample was composed of sixth grade students. In future studies, to put our current understanding of metacognition in a broader perspective, a larger picture is needed. So the metacognitive inventory developed in this study should be applied to different age groups.

Assessment of children's metacognition relied solely on the scores of a metacognition inventory. In further studies, different measures of metacognition could be used, such as teachers' ratings or observations about their students' metacognitive skills.

In the current study, to tap the correlation between metacognition and achievement, the students' course scores were obtained. These scores relied on traditional teacher-made classroom tests. It is strongly believed that, these grades are not true indicators of achievement.

In addition to the course grades, different criteria for the identification of academic achievement should be used. Rather than relying only on one criteria of achievement, various sources of information would be more valid indicators of academic success.

A longitudinal study with the same sample of the present study would provide us with more information about metacognition and its correlates. An example to this may be looking at their university entrance exam scores or life satisfaction/successes.

Finally, studies should be done about the social and emotional aspects of metacognition because the literature review shows that one's own regulation and control of cognitive processes and assessment of knowledge is relevant and accessible with regard to subjective feelings, motivation, confidence and even to cultural beliefs (Lories and Dardanne, 1998; Nelson, Kruglanski and Jost, 1998, cited in Yzerbyt).

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Bilişüstünün Ölçümü ve Okuduğunu Anlama, Okul Başarısı ve Yetenekle Olan İlişkisi

Özet

Bu çalışma ergenliköncesi normal ve üstün zekalı çocuklar için Türkçe bir bilişüstü ölçeği geliştirmeyi amaçlamaktadır. Araştırma iki aşamadan oluşmaktadır. İlk aşamada, dört altboyuttan (farkında olma, kendini denetleme, değerlendirme ve bilişsel yöntemler) oluşan bir envanter geliştirilmiştir. Yapılan analizler envanterin yüksek ve olumlu iç-tutarlılığa ve yeterli yapı geçerliliğine sahip olduğunu göstermiştir. Çalışmanın ikinci aşamasında, bilişüstü becerilerinin okuduğunu anlama, okul başarısı ve yetenekle ilişkisine bakılmıştır. Bunun için bir okuduğunu anlama testi ve öğrencilerin Türkçe, matematik, ve fen sene sonu karne notları kullanılmıştır. Araştırma sonucunda bilişüstü envanterinin farkında olma ve bilişsel yöntemler altboyutları ile okuduğunu anlama arasında anlamlı ve olumlu bir korelasyon bulunmuştur. Kendini denetleme ve değerlendirme altboyutları ile üstün yetenekli öğrencilerin fen not ortalamalarıyla anlamlı ve olumlu bir korelasyon bulunmuştur.

Anahtar sözcükler: Bilişüstü, bilişüstünün ölçümü, okuduğunu anlama, okul başarısı, yetenek