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LITERATURE REVIEW ON METACOGNITION AND METACOGNITIVE AWARENESS[1]

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ABSTRACT

In this study, it was aimed to review literature related to metacognition and metacognitive awareness. In order to achieve this goal, these topics will be reviewed under five main headings within this study. These are metacognition and metacognitive awareness, metacognitive models and theories, metacognition and science education, the measurement of metacognitive awareness and national and international studies on metacognitive awareness. Moreover, some sub-headings will follow the main headings.

Key words: Metacognition, metacognitive awareness, literature review

ÜSTBİLİŞ VE ÜSTBİLİŞSEL FARKINDALIK ÜZERİNE LİTERATÜR ARAŞTIRMASI

ÖZET

Bu çalışmada üstbiliş ve üstbilişsel farkındalık ile ilgili literatürün gözden geçirilmesi amaçlanmıştır. Bu amaca ulaşmak için, bu konular bu çalışmada beş ana başlık altında incelenecektir. Bunlar üstbiliş ve üstbiliş farkındalık, üstbilişsel modeller ve teoriler, üstbiliş ve fen eğitimi, üstbilişsel farkındalığın ölçülmesi ve üstbilişsel farkındalık üzerine ulusal ve uluslararası çalışmalardır. Ayrıca, bazı alt başlıklar ana başlıkları takip edecektir.

Anahtar Kelimeler: Üstbiliş, üstbilişsel farkındalık, literatür araştırması

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1. METACOGNITION AND METACOGNITIVE AWARENESS

The concept of metacognition emerged as a result of studies on how learning takes place in the human brain. In recent years, researchers interested in education have been especially curious about how the individual learns new knowledge and what kind of a learning process he/she goes through (Eggen & Kauchak, 2001). The concept of metacognition, first used by and added to literature by John Flavell in the early 1970s, was defined as information on the cognitive methods of a person and his/her productions related to it (Flavell, 1979). Therefore, it is the individual's awareness and thinking about their cognitive processes and strategies. The concept of metacognition has been described by many researchers, and concepts close to each other have been used for the description. For instance, Blakey and Spence (1990, p.1) defined metacognition as "thinking about thinking, to know what to know and what to not know". Welton and Mallan (1999) defined metacognition as a process in which students consciously control and direct their own thinking processes to think independently, and Martinez described metacognition (2006, p.966) as "control and monitoring of thought". According to these definitions, metacognition includes all stages that 'individuals experience before the learning process', 'during the process', and 'during the evaluation of the process'. Students' achieving metacognitive skills provides them with an idea of how they should behave in a new learning process, what and how much they need to study, how they should check the process, and how they should evaluate themselves at the end of the process (Akın, 2006).

Metacognitive awareness is the knowledge and control of individual's own thinking and learning activities (Kramarski et al., 2002). A very basic level of metacognitive awareness means that the individual is aware of his/her own thinking (Doğanay & Kara, 1995). This means, individuals are aware of their learning path and themselves. Metacognitive awareness being an abstract concept has led researchers to make different definitions of this concept and to make appropriate interpretations of the concept pursuant to research fields. Although there are some differences between the definitions given by researchers, it is emphasized that cognitive awareness is the control and regulation of one's cognitive processes. For example, Paris, Lipson and Wixon (1983) defined metacognitive awareness as being aware of one's own thoughts. Schraw and Dennison (1994) have described metacognitive awareness as individuals' planning, ranking, monitoring and better applying ability in a way that will directly boost their performance. In this context, metacognitive awareness may be defined as the work of acquiring and using the metacognitive thinking skills that an individual need throughout his/her life. Cognitive awareness also refers to the individual regulating his/her knowledge, learning processes, knowledge of cognitive and affective situations, conscious control and knowledge

of the individual, learning processes, cognitive and affective situations (Papaleontiou-Louca, 2003).

Metacognitive awareness allows individuals to strengthen their high-level thinking skills, to have knowledge about their own cognition, to develop their individual assessment skills, to identify strategies that are the cause of success or failure, and to plan and monitor learning situations in a way that will enhance their performance (Schraw & Dennison, 1994). It is also considered as an element of effective learning (Çetinkaya & Erktin, 2002; Paris & Jacobs, 1984; Schraw & Graham, 1997).

2. METACOGNITIVE MODELS AND THEORIES

Metacognition is a multidimensional structure that contains different types of information and processes. The fact that metacognition is a multidimensional structure provides researchers to present different taxonomies in identification and classification of information and processes. These techniques are explained below.

2.1. Flavell's Metacognitive Model

While Flavell was developing his metacognitive model, he was influenced by Jean Piaget's model and started from Piaget's "formal thinking phase". According to Flavell (1979), metacognitive knowledge consists of four stages, namely metacognitive experiences, activities and strategies, goals and tasks. Metacognitive information refers to individuals' belief in their learning, their desire for the way of learning, strategies to fulfill a task, and cognitive attempts and knowledge of the individual consists of variables such as functional information and strategical information (Cotterall & Murray, 2009; Flavell, 1979; Lai, 2011). According to Flavell (1979), metacognitive experiences are defined as "any awake consciousness that accompanies and belongs to a cognitive intervention and affective experience" (p.906). Activities and strategies are defined as cognition and behaviors to reach goals. Goals and duties are desires and results of a cognitive effort.

2.2. Brown's Metacognitive Model

According to Brown (1980), metacognition is divided into two main parts, namely the cognition of knowledge and the regulation of the cognition. The information of the cognition is divided into three categories as declarative knowledge, procedural knowledge and conditional knowledge. Declarative knowledge is about "knowing what", procedural knowledge is about "knowing how", conditional knowledge is about "knowing why" and "knowing when" (Brown,

1987). The arrangement of the cognition is divided into three dimensions: planning, monitoring and evaluation.

2.3. Schraw and Moshman's Metacognitive Model

Going around Brown's model in detail, Schraw and Moshman (1995) put forward a new model. In Schraw and Moshman (1995) model, metacognition is divided into two: knowledge of the cognition and regulation of the cognition. The knowledge of the cognition is the same as Brown's (1980) model: declarative knowledge, procedural knowledge and conditional knowledge. The regulation of cognition consists of planning, monitoring and evaluation.

2.4. Jacobs and Paris's Metacognitive Model

Jacobs and Paris (1987) took metacognition into consideration under two sub-categories as self-evaluation and self-management. Self-evaluation is mainly based on the individual's personal thoughts and ideas (Akın, 2006), which means self-evaluation is similar to the structure that is named as cognition management information by researchers. On the other side, self-management is expressed as the behavioral demonstration of the things that the individual has learned. In other words, self-management is similar to the cognition management (Jacobs & Paris, 1987). Self-evaluation was divided into three categories: declarative knowledge, procedural knowledge and conditional knowledge. Also, self-management consists of three categories such as planning, evaluation and regulation.

2.5. Tobias and Everson's Metacognitive Model

Tobias and Everson's (2002) metacognitive model consists of planning, selecting strategies, evaluation of learning and monitoring the information. These stages are being monitored continuously. According to this model, the way an individual plan the information, the strategies that they use to learn, the way they evaluate the information and the way they monitor the information should be monitored continuously.

2.6. Nelson and Narens's Metacognitive Model

Identifying metacognition as controlling and monitoring cognitive development, Nelson and Narens (1990) presented an alternative model for metacognition (De Bruin, Thiede, Camp, & Redford, 2011; Kornell & Metcalfe, 2006). In Nelson and Narens' (1990) model, two levels that are related to each other are mentioned as senior level and target level. There is a symmetric relationship between these two levels and a two-sided information flow exists. In the information flow, if a problem occurs on target level, monitoring is activated; for senior level,

the control system steps in to inform these levels. Nelson and Naren (1990) explained how these models are controlled and monitored in detail. In their explanation, three phases are mentioned about learning: acquisition of the information, storing it and checking it by recalling.

2.7. Efklides' Metacognitive Model

Efklides' (2008) metacognition model consists of many stages and explains the concept of metacognition in detail. According to this model, metacognition is divided into three categories, namely social, individual awareness and non-cognitive levels. Consisting of different levels, this model is also made up of different dimensions such as *Metacognitive Knowledge, Metacognitive Experiences and Metacognitive Skill.* Within this perspective, it differs from Nelson and Narens's metacognitive model. In this model, metacognitive information contains information about the duties, goals and strategies of the individual. Thanks to metacognitive experiences, individuals are becoming aware of when and where they should use the information. In other words, metacognitive experiences stand between the individual and duties. Metacognitive skills mean individual's selection of right strategies throughout the learning process.

2.8. Schraw's Metacognitive Model

Schraw's (1998) metacognitive model is adopted in the present study. According to Schraw (1998), metacognition is divided into two main areas: the regulation of cognition and knowledge of cognition. There are two important points about knowledge of cognition and regulation of cognition. The first one is that the two of them are related to each other. The second one is that both of them have a wide spectrum; as a result, it is domain-general by nature (Schraw, 1998; Akın, 2006).

2.8.1. Knowledge of Cognition

According to Schraw (1998, p.114), the knowledge of cognition is about "individual's own cognition and the general knowledge about what they know about the cognition". It includes three sub-categories, namely declarative knowledge, procedural knowledge and conditional knowledge.

2.8.1.1. Declarative Knowledge

Declarative Knowledge is the knowledge about the situations that individuals are affected by, its own cognitive system and what they know or don't know, or whether they do their own duty or not (Schraw, 2000). Declarative knowledge consists of all the knowledge that individual

considers as writable, speakable or explainable. Within this sub-dimension, these explanations can be presented as examples: "I understand my intellectual strengths and weaknesses", "I am good at the organizing information", "I know what the teacher expects me to learn" (Schraw & Dennison 1994).

2.8.1.2. Procedural Knowledge

Procedural knowledge is the knowledge of how and in what way the individuals would apply their learning processes and their problem-solving strategies (Schraw & Dennison, 1994). As procedural knowledge provides individuals the knowledge of how to use the information and regulate it, those who have advanced procedural knowledge fulfill duties more automatically, have a wider strategy repertoire, and they have the higher possibility of using different strategical techniques while solving problems (Pressley et al., 1987; Schraw, 1998). "I try to use the strategies that have worked in the past", "I am aware of what strategies I use when I study", "I have a specific purpose for each strategy I use" can be shown as sample statements for this sub-dimension (Schraw & Dennison, 1994).

2.8.1.3. Conditional Knowledge

Conditional knowledge refers to the information that individuals have about their learning processes, when and why it is used and its limitations (Schraw & Dennison, 1994). Namely, it is the knowledge of how a thing is done, or whether it is done individually or not and in which situation it is done or not (Yıldız, 2010). As conditional knowledge helps to improve the selection of cognitive sources efficiently, to use strategies efficiently and to make changes according to the needs of conditional needs, individuals with high level of conditional knowledge are considered efficient enough to determine the most appropriate strategy in the learning process (Kyllonen & Woltz, 1989; Mclnerney & Mclnerney, 2013; Schraw, 2001). The expressions that are stated in this sub-dimension can be mentioned as "I learn best when I know something about the topic", "I use different learning strategies depending on the situation", "I can motivate myself to learn when I need to" (Schraw & Dennison, 1994).

2.8.2. Regulation of Cognition

According to Schraw (1998), the regulation of cognition is the behavior that controls the cognitive knowledge and consists of five main components, namely planning, information management strategies, monitoring, debugging and evaluation (Schraw & Dennison, 1994).

2.8.2.1. Planning

Planning consists of selecting the appropriate strategies, sorting them out and using the right sources for the performance, determining the goals and timing (Schraw & Moshman, 1995). In this sense, it is seen that planning includes recognizing the mission, planning the learning and using strategy stages (Saraç, 2010). In this sub-dimension, such statements as "I think about what I really need to learn before I begin a new task", "I set specific goals before I begin a task", "I ask myself questions about the materials, before I begin", "I think of several ways to solve a problem and choose the best one" can be mentioned as examples (Schraw & Dennison 1994).

2.8.2.2. Information Management

Information Management consists of strategies and skills such as regulation, summarizing, detailing and selective focusing used in order to make the information more effective (Schraw, 2000). "I consciously focus my attention on important information", "I slow down when I encounter important information", "I draw pictures or diagrams to help me understand while learning", "I focus on overall meaning rather than specifics" are statements that can be shown as an example of this sub-dimension (Schraw & Dennison, 1994).

2.8.2.3. Monitoring

Monitoring contains an individual's awareness of his/her performance while he/she is dealing with a specific work, controlling him/herself on a regular basis in the learning process, determining mistakes and understanding whether the course is understood or not (Akın & Abacı, 2011; Saraç, 2010; Schraw & Dennison, 1994). As monitoring skill helps individual regulate their cognitive process and decide whether they understand or not, it is seen as the main component for efficient learning (Saraç, 2010; Schraw, 1998). These expressions can be seen as an example: "I ask periodically if I am meeting my goals", "I consider several alternatives to a problem before I answer", "I periodically review to help me understand important relationships" (Schraw & Dennison, 1994).

2.8.2.4. Debugging

Debugging consists of the strategies that the individuals use for fixing the problems in understanding and performance (Schraw, 2000). "I change strategies when I fail to understand", "I stop and go back over new information that is not clear", "I stop and reread when I get confused" are sample expressions of this sub-dimension (Schraw & Dennison, 1994).

2.8.2.5. Evaluation

Evaluation is passing a general judgement by the individual on their learning productions, cognitive regulation process and effectiveness of strategies (Saraç, 2010; Schraw, Crippen, & Hartley, 2006; Schraw & Dennison, 1994; Schraw & Moshman, 1995). Evaluation is very important for the individual's future learning and regulations (Schraw & Dennison, 1994). Within the sub-dimension, "I ask myself if there was an easier way to do things after I finish a task", "I summarize what I have learned after I finish", "I ask myself how well I accomplish my goals once I am finished" are statements that can be given as examples (Schraw & Dennison, 1994).

3. METACOGNITION AND SCIENCE EDUCATION

To provide students with the ability to conduct research is one of the main goals of science education. To achieve this goal, it is important to provide students with the ability to learn how to learn, to develop self-regulation skills about learning strategies and to provide students with the ability to recognize what they think (Soylu, 2004; Yıldız, 2008). The metacognition, which serves this purpose, enhances the students' attention towards lessons and affects the academic achievement positively (Akdur, 1996; Case et al., 1992; Çakıroğlu, 2007; Desoete & Roeyers, 2002; Flavell, Flavell, & Green, 2001; Manning & Payne, 1996; McDougall & Brady, 1998; Özsoy, 2007; Taraban, Rynearson, & Kerr, 2000). Besides, metacognition has an important effect on the knowledge of a person, on his/her own cognitive processes, on this knowledge controlling the cognitive processes (Flavell, 1987) and on cognitive process activities such as monitoring and organizing learning, problem solving, comprehending, reasoning, monitoring and organizing (Çetinkaya & Erktin, 2002; Metcalfe, 2000; Öz, 2005). In addition, when compared to other students, students with metacognitive skills are seen as students who are more aware of their weaknesses and strengths and who try to further develop their own learning skills. Researchers are emphasizing that in the learning process, effective and meaningful learning levels of students can be increased to the extent that their metacognitive awareness can be improved (Bransford, Brown, & Cocking, 2000; Jones, Farquhar, & Surry, 1995).

In the 1980s, when inquiry-based learning approach in science education became widespread, the concept of metacognition began to emerge (Carin & Bass, 2001; Hartman, 2002; Llewellyn, 2005; Schraw et al. 2006). In these studies, it has been indicated that inquiry-based learning approach is an effective learning approach in improving students' metacognitive skills. The importance and benefits of metacognition are put forward by these studies. However, it has

been discussed in Turkey since the 2000s. Despite the abovementioned studies on metacognition, it seems that researchers still cannot have a common definition for metacognition. For that reason, it is significant to discuss the concept of metacognition in detail.

4. THE MEASUREMENT OF METACOGNITIVE AWARENESS

One of the most important problems of measuring metacognitive awareness is the method that will be used for a valid and reliable measurement (Panaoura & Philippou, 2003) because it is a difficult process to measure metacognitive awareness (Desoete, 2008; Veenman et al., 2006). When the literature is analyzed, it is seen that different measurement techniques are developed. It is also observed that research have been done in order to criticize the validity and reliability of the developed tools (Veenman et al., 2005).

In order to measure metacognitive awareness, surveys, scales, interviews, think-aloud protocol, teacher evaluation scales, monitoring check-lists, online diaries, portfolios and calibration techniques, inventories are used (Karakelle & Saraç, 2007; Veenman et al., 2006; Yurdakul, 2004; Zimmerman & Martinez-Pons, 1990). Besides personal inventories, interviews, think-aloud protocols and teacher scale surveys (Desoete, 2007) are suggested techniques to measure metacognitive skills. In general, these techniques used for measuring and evaluating metacognitive awareness are divided into two groups: concurrent and non-concurrent techniques. Concurrent techniques are obtained by recording the performance of the individual concurrently while fulfilling a cognitive task. Self-evaluation surveys, think-aloud protocols and interview techniques are examples of concurrent techniques (Afflerbach, 2000; Özsoy, 2008; Yurdakul, 2004). Non-concurrent evaluation techniques are obtained by observing general characteristics of an individual's metacognitive skills and recording it in a different time than the performance. These techniques include evaluation techniques, interviews and teacher evaluation techniques (Karakelle & Saraç, 2010; Veenman et al., 2006; Yurdakul, 2004). While concurrent techniques evaluate the existing situation that is related to a specific metacognitive task, non-concurrent techniques evaluate typical situations. Additionally, it is stated in recent research that multi-method design techniques that include different techniques should be used (Desoete, 2008; Karakelle & Saraç, 2007; Veenmann et al., 2005).

When concurrent and non-concurrent techniques are taken into consideration, the most frequently used technique is the rating scales technique, since it is the least problematic among others in respect to both evaluation and application. The reason for this is that it provides scoring objectivity and is applicable to crowded groups in research for determining

metacognition level or metacognitive awareness. On the other hand, there are some criticisms on rating scales. Especially, it is remarked that metacognitive techniques are not enough as they are based on the individual's declaration. Therefore, some researchers argue that most of the rating scales just evaluate metacognitive knowledge and other techniques are required for observation and control functions (Karakelle & Saraç, 2010; Pintrich, Walters, & Baxter, 2000). Another criticism is that rating scales are not divided into valid and reliable sub-dimensions or even when they are, same subjects may take place in different dimensions. This is explained as the relation between dimensions and scales are seen limited as they only determine the level of metacognitive knowledge or awareness (Karakelle & Saraç, 2007; 2010).

When the literature is taken into consideration, it is seen that Metacognitive Awareness Inventory (MAI), developed by Schraw ve Dennison (1994), is the most commonly used scaling technique (Küçük-Özcan, 2010). This scaling technique has two main parts, namely metacognitive knowledge and metacognitive regulation. Adopting the perspective of this scaling technique, Sperling, Howard, Miller and Murphy (2002) developed Jr MAI that has two versions measuring the metacognitive skills of secondary school students.

In order to develop a scale for measuring metacognitive awareness, Çetinkaya and Erktin (2002) aimed to identify the previously used measurement tools and their weaknesses. In this sense, they examined the skills that are to be evaluated as metacognitive. The researchers working in the field of mathematics and science evaluated these skills and put them in order of importance. For every skill, they analyzed the averages and used the highest average in the measurement process. At the end of the research, a survey-like scaling technique was developed that provides teachers with the opportunity to determine the situations where students show metacognitive characteristics. This scaling technique is formed with metacognitive field questions such as cognitive strategies, planning, monitoring, self-control, evaluation and awareness.

5. NATIONAL AND INTERNATIONAL STUDIES ON METACOGNITIVE AWARENESS

Since Flavell's discovery of the term metacognition, research in the field of metacognitive awareness have increased rapidly (e.g., Başaran, 2013; Doğanay Bilgi & Özmen, 2014; Downing, 2009; Efklides, 2008; Garrett, Mazzocco, & Baker, 2006; Göğebakan-Yıldız, Kıyıcı, & Altıntaş, 2016; Hamdan et al., 2010; Hong-Nam & Leavell, 2011; Kalkan & Cerit, 2007; Karaoğlan-Yılmaz, 2016; Kramarski, Mevarech, & Arami, 2002; Mega et al., 2014; Memiş & Arıcan, 2013; Nosratinia et al., 2014; Sarwar et al., 2009; Schraw, 2009). While research on

metacognitive awareness have been carried out since 1978 abroad, in Turkey studies in this area have begun with the research that Yüzbaşıoğlu conducted in the field of "language teaching" in 1991. In terms of metacognitive awareness studies conducted with students in and out of the country, the relationship levels of metacognitive awareness were tried to be determined with many variables such as academic achievement, age, gender, class level, reading skill, learning level, attitude, perception, motivation, intelligence, problem-solving, responsibility, epistemological beliefs, motivation, socio-demographic variables, motivation, self-efficacy (e.g., Ateş, 2013; Bağçeci, Döş, & Sarıca, 2011; Demirel & Aslan-Turan, 2010; Emrahoğlu & Öztürk, 2010; Pilten, 2008; Sarıkahya, 2017; Selçioğlu-Demirsöz, 2010; Takallou, 2011; Turan, 2013). In addition to the studies of relationship between metacognitive awareness and the various variables, it is also possible to find the studies conducted for the change, development or increase of metacognitive awareness in the literature (e.g., Annevirta & Vauras, 2006; Baylor, 2002; Conner, 2000; Demircioğlu, 2008; Deniz, 2017; Hong-Nam & Leavell, 2011; Kuhn, 2000; Othman, 2010; Rosetta, 2000) In this section, outcomes and results of the prominent metacognitive awareness studies conducted with the students were tried to be discussed.

When the relationship between metacognitive awareness and learning is taken into consideration, many researchers found out that metacognitive awareness had a positive effect on learning (e.g., Anderson & Nashon, 2007; Blank, 2000; Cornoldi, Carretti, Drusi, & Tencati, 2015; Efklides & Vlachopoulos, 2012; Hart & Memnun, 2015; Jou, 2015; Sandi-Urena, Cooper, & Stevens, 2011; Shamir, Mevarech, & Gida, 2009; Vrugt & Oort, 2008; Wang, 2015). When metacognitive awareness of students develops, their effectiveness in the learning process increases (Akturk & Sahin, 2011; Azevedo, Greene, & Moos, 2007; Desoete, 2008; Jones, Farquhar, & Surry, 1995; King, 2003) and they use learning strategies effectively (Drmrod, 1990).

When the literature was examined, it is noteworthy that there was a great deal of studies that analyze the relationship between metacognitive awareness and achievement (e.g., Alcı & Yüksel, 2012; Canca, 2005; Carey et al., 2014; Cooper, 2008; Gürşimşek, Çetingöz, & Yoleri, 2009; Mega et al., 2014; Memiş & Arıcan, 2013; Tok, Özgan, & Döş, 2010; Zulkiply et al., 2008). Some studies showed that there was a significant relationship between metacognitive awareness and academic achievement, and also showed that academic achievement of students with high metacognitive awareness increases (e.g., Akçam, 2012; Alcı et al., 2010; Alemdar, 2009; Ayazgök, 2013; Carey et al., 2014; Coutinho, 2007; Çakır & Yaman, 2015; Göçer, 2014;

Mega et al., 2014; Rezvan, Ahmadi, & Abedi, 2006; Schleifer & Dull, 2009; Veenman et al., 2006; Young & Fry, 2008; Zimmerman, 2008). For example, as a result of the study conducted by Young and Fry (2008) analyzing the relationship between university students' metacognitive awareness and academic achievements, they found out that there was a significant relationship between participants' metacognitive awareness and academic achievements. A similar study was carried out by Bağçeci, Döş and Sarıca (2011) in Turkey. In this study, it was aimed to investigate the relationship between metacognitive awareness of the 7th grade students and their Level Placement Examination (SBS) and their year-end achievement scores. The study was conducted with 194 seventh grade students. Metacognitive Awareness Inventory (MAI) was used to determine the metacognitive awareness of the students. As a result of the study, it was determined that there was a significant relationship between the metacognitive awareness of the students and SBS achievements in a positive way. It was also found that there was a positive relationship between the metacognitive awareness of the students and the achievement scores at the end of the year. That is, those with higher levels of metacognitive awareness had higher levels of achievement, while those with lower levels of metacognitive awareness had lower levels of achievement. High metacognitive awareness results in high performance, and therefore metacognitive awareness affects the achievement positively. However, there are some studies which showing no significant relationship between metacognitive awareness and achievement (e.g., Tuncer & Doğan, 2016).

There are also studies investigating the relationship between students' metacognitive awareness and their gender. Some researchers (Altındağ, 2008; Anandaraj & Ramesh, 2014; Bağçeci et al., 2011; Evran & Yurdabakan, 2013, İflazoğlu-Saban & Saban, 2008; Karatay, 2010; Martin et al., 2000; Selçioğlu-Demirsöz, 2010; Sen, 2012; Yavuz, 2009) found that girls had more advanced metacognitive awareness. For example, studies conducted by Evran and Yurdabakan (2013) on the levels of metacognitive awareness of 6th, 7th and 8th grade students in terms of various variables revealed that there was a meaningful difference in the students' metacognitive awareness levels in favor of the girls. Alongside, there are also studies that found that male students had more advanced metacognitive awareness (Akyolcu, 2013). On the other hand, there were also studies suggesting that there was no significant difference between metacognitive awareness and gender (e.g., Bars, 2016; Duran, 2011; O'Neil & Brown, 1998; Özsoy et al., 2010; Özsoy & Günindi, 2011; Padeliadu et al., 2002; Rahman et al., 2010; Sezgin-Memnun & Akkaya, 2009; Sperling, Howard, Miller, & Murphy, 2002; Tuzcuoğlu, 2014; Zakaria et al., 2009).

Another variable, whose relation with metacognitive awareness is analyzed, is class level. Some researchers (Akçam, 2012; Baysal, Ayvaz, Çekirdekçi, & Malbeleği, 2013; Evran & Yurdabakan, 2013; Özsoy & Günindi, 2011; Sezgin-Memnun & Akkaya, 2012; Sperling, Howard, Miller, & Murphy, 2002; Yürüdür, 2014) found a meaningful relationship between metacognitive awareness of students according to grade levels. For example, in their studies, Baysal, Ayvaz, Çekirdekçi and Malbeleği (2013) examined whether metacognitive awareness levels of university students changed in terms of class level and they reached a conclusion that students had a high-level metacognitive awareness that differentiates by class level. On the other hand, some researchers (Baykara, 2011; Karadeniz Bayrak & Erkoç, 2008; Özsoy, Çakıroğlu, Kuruyer, & Özsoy, 2010; Temur, Kargın, Bayar, & Bayar, 2010) could not find a significant relationship between metacognitive awareness and class level.

There are also studies in the literature that have related issues between metacognitive awareness and age (Akyolcu, 2013; Ormond et al., 1991; Özsoy, Çakıroğlu, Kuruyer, & Özsoy, 2010; Stewart et al., 2007). Studies showed that metacognitive awareness developed with age, and that different elements had different developmental time frames (Akpunar, 2011; Hanten et al., 2004; Stewart et al., 2007). For example, the results of Gren and colleagues' study (2000) revealed that as learner's age increases, their levels of defining similarity and differences, recalling ways of thinking, use of mind, and use of mental words increase. In addition, researchers emphasized that metacognitive awareness could be learned. Likewise, Akpunar (2011) stated that metacognitive awareness develops from younger ages, depending on growth and development. However, Akpunar (2011) also stated that control and participation in the learning process takes place later.

There are studies that conclude that metacognitive awareness and intelligence are interdependent and that there is a meaningful relationship between these two variables (e.g., Alexander, Johnson, Albano, Freygang, & Scott, 2006; Rozencwajg, 2003; Veenman & Beishuizen, 2004; Veenman & Spaans, 2005; Veenman, Wilhelm, & Beishuizen, 2004). A large part of these studies examined the relationship between these two variables in different age groups. For example, Veenman, Wilhelm and Beishuizen (2004) found a significant positive correlation between intelligence and metacognitive awareness in all age groups in a cross-sectional survey conducted with 4th, 6th, and 8th grade and university students. In addition, it was found that gifted and talented students had higher metacognitive awareness and more effective use of metacognitive skills and strategies, although the number of studies that examine the metacognitive awareness of gifted and talented students in the literature is rather

limited (Alexander, Carr, & Schwanenflugel, 1995; Dover & Shore, 1991; Kanevsky, 1992; Kurtz & Borkowski, 1987; Schneider, Körkel, & Weinert, 1987; Sheppard, 1992). However, in some studies, it was concluded that metacognitive awareness and intelligence might be independent of each other and that there was no meaningful relationship between them (Allon, Gutkin, & Bruning, 1994; Coutinho, 2006; Karakelle, 2012). For example, in Dresel and Haugwitz's (2006) study, it was stated that there was a negative relationship between intelligence level and metacognitive awareness, thus indicating that metacognitive awareness decreases as intelligence score increases.

It is possible to see the studies in which problem-solving and metacognitive awareness were investigated together (e.g., Aydemir & Kubanç, 2014; Balcı, 2007; Cozza & Oreshkina, 2013; Desoete, Roeyers & Buysse, 2001; Doğan, 2013; Gartmann & Freiberg, 1994; Gürşimşek, Çetingöz, & Yoleri, 2009; Kapa, 2001; Kramarski, 2004; Kramarski, Mevarech, & Arami, 2002; Meijer, Veemen, & Wolters, 2006; Pugalee, 2001; Rudder, 2006; Schurter, 2001; Swanson, 1990; Yimer & Ellerton, 2006). In many studies that it was found that there was a meaningful and positive relationship between these two variables and the students with higher metacognitive awareness level had a more positive problem-solving than the students with lower metacognitive awareness level (e.g., Alcı et al., 2010; Bakioğlu et al., 2015; Balcı, 2007; Boran, 2016; Christoph, 2006; Coutinho, Wiemer-Hastings, Skowronski, & Britt, 2005; Day, Espejo, Kowollik, Boatman, & McEntire, 2007; Goos et al., 2002; Howard, McGee, Shia, & Namsoo, 2000; Metallidou, 2009; Nair & Ramnarayan, 2000; Öztürk, 2009; Teong, 2003; Woo, Harms, & Kuncel, 2007; Vukman, 2005). For example, in Boran's (2016) study on the effects of metacognitive awareness and critical thinking tendencies on perceived problem-solving skills of gifted and talented students, it was found that the perceptions of metacognitive awareness, critical thinking tendencies and problem-solving skills of gifted and talented students were high. The structural model developed based on the relationship between metacognitive awareness of gifted and talented students, their tendency to think critically, and the sub-dimensions of problem-solving skills is confirmed. The findings of this model revealed that gifted and talented students, along with metacognitive awareness, tend to solve the problem with their critical thinking instead of avoiding the problem when they face it. A similar study was conducted by 638 university students by Anandaraj and Ramesh (2014). The study examined the relationship between problem-solving skills and metacognitive awareness by using semi-experimental design. Data of the study were collected by using metacognitive awareness inventory and solving skills test of physics problem. At the end of the study, researchers emphasized that there was a positive relationship between problem solving ability

and metacognitive awareness. As a result, individuals with high metacognitive awareness are individuals who are aware of their own learning, what they are doing, in which stage they are in a problem-solving process and how much they know in the process of problem-solving (Akyolcu, 2013).

Studies (Alcı & Yüksel, 2012; Bars, 2016; Cera et al., 2013; Çikrıkci, 2012; Keskin, 2014; Landine & Steward, 1998; Nosratinia et al., 2014; Rahimi & Abedi, 2014; Sapancı, 2012; Yailagh et al., 2013; Yürüdür, 2014) also revealed that there was a significant relationship between self-efficacy and metacognitive awareness. For example, Yürüdür (2014) found that there was a significant relationship between metacognitive awareness and self-efficacy levels of university students as a result of a study of university students' perceptions of metacognitive awareness and self-efficacy levels. Students with higher self-efficacy perceptions are more likely to use metacognitive awareness strategies (Pintrich & De Groot, 1990), and students having lower self-efficacy and depending on external evaluation have lower metacognitive awareness (Garner & Alexander, 1989; Kleitman & Stankov, 2007).

Apart from the variables mentioned above, it is also possible to find studies examining the relationship between variables such as socio-economic status (Akçam, 2012; Evran & Yurdabakan, 2013; İflazoğlu-Saban & Saban, 2008), course-study strategies (Doğanay & Demir, 2011; Gurb, 2000; Hwang & Vrongistinos, 2002), questioning styles (Kramarski, 2008; O'Neil & Brown, 1998), pedagogies (Hall et al., 1999), motivation towards science (Atay, 2014), environmental attitude (Malkoç, 2011), attitude towards technology (Bakioğlu et al., 2015; Tunca & Alkın-Şahin, 2014), decision making processes (Batha & Carroll, 2007; Mason & Santi, 1994; Ormond, Luszcz, Mann, & Beswick, 1991), intelligent executive (Göçer, 2014; Mevarech & Fridkin, 2006; Mevarech & Kramarski, 2003), epistemological beliefs (Güven & Belet, 2010; Jena & Ahmad, 2013; Topçu & Yılmaz-Tüzün, 2009) and the metacognitive awareness of students. Moreover, it is possible to find studies analyzing the impacts of metacognitive awareness strategies on regulation of cognition (Mevarech & Amrany, 2008), satisfaction (Weaver, 2012), perception (Sandall, Mamo, Speth, Lee, & Kettler, 2014), conceptual persistence (Alemdar, 2009; Georghiades, 2004) and language teaching (Garrett, Mazzocco, & Baker, 2006; Kramarski & Hirsch, 2003; Peymanfar, 2010). In addition, scale development (Blum & Staats,1999; O'Neil & Abedi, 1996; Schraw & Dennison, 1994; Sperling et al., 2002), scale adaptation (Akın, Abacı, & Çetin, 2007; Çetinkaya & Erktin, 2002; Namlu, 2004; Soydan, 2001) and meta-analysis studies (Hattie, 2009; Zohar & Barzilia, 2013) related

to metacognitive awareness have been carried out, although they are few in number compared to other studies.

Finally, it was seen as a result of researches that different teaching methods and techniques such as cooperative learning (Goos & Galbraith, 1996; Olğun, 2011; Sandi-Urena, Cooper, & Stevens, 2011), problem based learning (Demirel & Arslan-Turan, 2010; Kiremitci, 2011; Kuvac, 2014), inquiry based computer assisted teaching (White & Frederiksen, 1998), constructivist based learning (Yurdakul, 2004; Yurdakul & Demirel, 2011), case study method (Fırat-Durdukoca, 2017), project based learning (Başbay, 2007), computer based learning (Ersoy, 2013; Kapa, 2001; Olgun, 2006), web-based collaborative inquiry learning (Raes et al., 2012), using science diary (Çavuş, 2015), science writing heuristic (Tucel, 2016; Ulu, 2011), web based learning (Bannert & Mengelkamp, 2008), metaphor supported teaching (Sillman & Dana, 1999), classroom discussion (Goos & Galbraith, 1996; Mason & Santi, 1994), cognitive coaching (Demir, 2009), conceptual change based teaching (Yıldız, 2008), concept map (Akdur, 1996; Martin et al., 2000) were used for the detection, identification and development of metacognitive awareness of students, and these teaching methods and techniques increase metacognitive awareness. However, it was also determined as a result of investigations that teaching methods and techniques such as creative drama (Selçioğlu-Demirsöz, 2010), technology supported brain-based learning (Oktay & Çakır, 2013; Oktay-Esen, 2014), web-based teaching (Baltacı & Akpınar, 2011), brainstorming (Duru, 2007) and inquiry-based learning (Çakar, 2013; Çakar-Özkan & Talu-Bümen, 2014) did not any cause a change or influence on the metacognitive awareness of the students.

5.1. Summary

In general terms, metacognitive awareness was found to be influential in the acquisition of knowledge as well as effective learning, critical thinking, reasoning, problem solving, and social interaction skills as much as knowledge structuring, comprehension, recalling and practicing learnings. In addition to this, an individual can control how he/she learns with metacognitive awareness, develop self-regulation and control skills, and choose a facilitative way to reach its goals. Alongside, while it was examined whether metacognitive awareness could be improved or not, in the light of the recent study results showing that metacognitive awareness could be improved, it was stated with the researchers that this improvement was important in learning and various life skills if it is improved in a more conscious and deliberately organized activities.

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