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# PRESERVICE SCIENCE TEACHERS' METACOGNITIVE AWARENESS LEVELS

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**Abstract:**

The purpose of this study was to determine preservice science teachers' metacognitive awareness levels and to investigate whether their metacognitive awareness levels differ in terms of gender and grade level. A total of 188 preservice science teachers participated in the study. Personal Information Form and the Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison (1994) were utilized as data collection tools in the study. The data obtained were analyzed using the PASW Statistics 18 (SPSS Inc.). According to the results, preservice science teachers' metacognitive awareness levels were determined generally high. However, a significant gender difference favoring female preservice science teachers was found in terms of debugging sub-component. When the total and sub-component scores of MAI were examined by grade level, a significant difference was found in the sub-components apart from conditional knowledge and debugging. Suggestions were made based on the findings obtained from the study.

**Keywords:** metacognition; metacognitive awareness; preservice science teachers; science teaching; teacher training

## 1. Introduction

In recent years, individuals who know what they know, what they should know, and thus can control their learning processes are needed. Metacognition studies carried out

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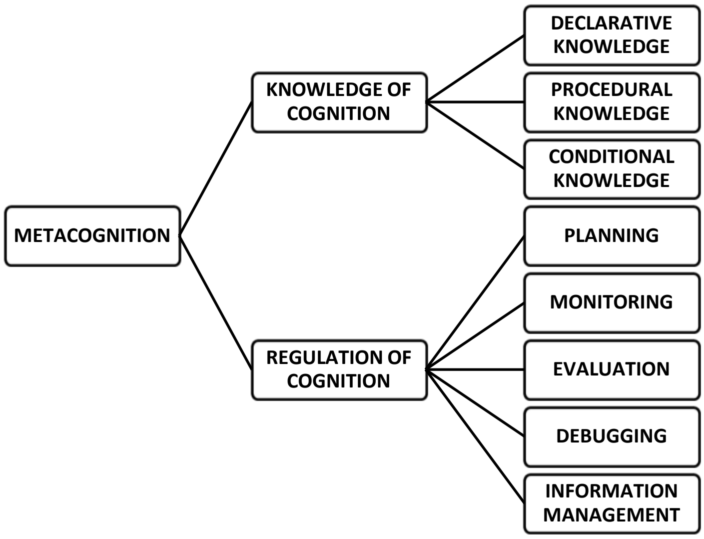
in the field of education as a result of this need and expectation have gained great importance. Metacognition refers to 'one's knowledge concerning one's own cognitive processes and products or anything related to them' (Flavell, 1976, p. 232).

According to Brown (1987), in its broadest sense, it is one's knowledge and control of one's own cognitive system. In other words, it is the awareness of one's own thinking, awareness of the content of one's conceptions, an active monitoring of one's cognitive processes an attempt to regulate one's cognitive processes in relationship to further learning, and an application of a set of heuristics as an effective device for helping people organize their methods of attack on problems in general (Hennessey, 1999, p.3). Metacognitive awareness, defined as being informed of one's own cognitive aspects, and planning, regulating and monitoring one's learning situations so as to increase one's success (Schraw & Dennison, 1994) is an extremely important structure that affects learning processes. Individuals should first be aware of what they understand and what they do not understand in the process of learning. Then, learners should be able to determine the learning targets by defining what they should know more about the task that they work on. Third, they should be able to plan their learning and choose suitable learning strategies. In other words, they should be able to decide on an action plan (or plans) to achieve the targets they determine. Lastly, they should be able to monitor and assess whether their objectives were fulfilled (Hmelo-Silver, 2004).

Metacognition consists of two main components as knowledge of cognition and regulation of cognition (Paris & Winograd, 1990; Schraw & Dennison, 1994; Schraw & Moshman, 1995) (see Figure 1). Knowledge of cognition refers to what individuals know about their own cognition or about cognition in general and includes three sub-components: declarative, procedural, and conditional knowledge (Shraw, Olafson, Weibel, & Sewing, 2012). Declarative knowledge consists of the factors affecting one's performance and knowledge about oneself as a learner (Schraw & Moshman, 1995). That one knows the limitations of one's own mental system can be shown as an example of declarative knowledge. Procedural knowledge is one's knowledge about strategies and other procedures. In other words, it is one's knowledge of how to use the strategies to solve a problem. For example, many people make use of such strategies as taking notes, slowing down for important information, skimming unnecessary information, using mnemonics, summarizing main ideas and testing oneself periodically (Schraw, Olafson, Weible, & Sewing, 2012).

The fact that individuals have a high level of procedural knowledge supports the spontaneous and rapid use of the necessary strategies for the regulation of the cognition (Schraw & Moshman, 1995). Conditional knowledge means that an individual knows when and why he/she will use declarative and procedural knowledge (Herscovitz, Kaberman, Saar, & Dori, 2012). In other words, it is the knowledge of an individual on why and when to use a particular strategy. Individuals with a high level of conditional knowledge can assess the demands of a particular learning situation better, and thus, choose the most suitable strategies for that situation (Schraw et al., 2012).

**Figure 1:** Metacognition and its components and sub-components (Schraw & Dennison, 1994)




Regulation of cognition refers to a set of activities that help individuals control their learning (Shraw, 1998). As seen in Figure 1, regulation of cognition consists of five sub-components: planning, monitoring, evaluation, debugging and information management (Artzt & Armour-Thomas, 1992; Baker, 1989 as cited in Schraw & Dennison, 1994). Planning emphasizes the selection of appropriate strategies and determination of cognitive skills for effective performance (Schraw & Dennison, 1994). Also, planning includes target setting, activating prior knowledge on the subject and time management (Schraw, Crippen, & Hartley, 2006). Monitoring includes the evaluation of the effectiveness of one's learning strategies and determining performance errors (Schraw & Moshman, 1995). For example, the fact that one is aware of making a mistake while making a mathematical calculation can be regarded as monitoring.

Evaluation means the evaluation of one's own learning. The reevaluate of one's targets, changing of the estimations and solidifying one's mental gains can be shown as an example (Schraw et al., 2012). Debugging means the strategies used to correct conception and performance errors in the process of learning. That a person asks for help from others when he does not understand a subject can be shown as an example. The information management includes the use of the chain of strategies and skills to effectively process the information. For example, that an individual creates one's own examples in order to make information more meaningful can be accepted as information management (Schraw & Dennison, 1994).

Considering that science subjects are perceived as subjects that are hard to understand, that students know their learning, monitor the learning process, use appropriate learning strategies in order to cope with difficulties and self-assessment will facilitate meaningful and permanent learning. Paris & Winograd (1990) liken metacognition to a mirror on the knowledge and thoughts of a person in a way and indicate that the reflection can either come from the inside of an individual as well as other people. Thus, students should be encouraged by teachers to determine the difficulty of the task, effectively monitor their perception, plan their learning, monitor their performance success and assess themselves in science education (Wagner & Stemberg, 1984). In addition, for successful learning, teachers should know what the learning strategies are, their requirements, and when, why and how to use them.

Teachers should plan, monitor and assess the learning process considering the personal differences of the students. Teachers should use their knowledge of cognition and skills effectively in the planning of a lesson, determining whether a teaching approach is as useful as expected, changing it when it is not useful, and evaluating the learning process at the end of the lesson. In other words, the effectiveness of the learning process is closely related to teachers' skills of using their knowledge of cognition and skills before, during and after the lesson. At this point, teachers with low metacognitive awareness will fall short of supporting knowledge of cognition and skills of the students in the effective learning process regulation. Thus, metacognitive awareness of science teachers should be high for qualified science teaching. In this direction, the initial aim of the study was to determine the metacognitive awareness levels of preservice science teachers who will start to perform their profession in the near future.

## 2. Purpose

The purpose of the study was first to determine the metacognitive awareness levels of preservice science teachers and then to investigate whether their awareness levels differ in terms of gender and grade level. The answers to the following questions were sought in line with this objective:

1) What are the metacognitive awareness levels of preservice science teachers?
2) Is there a significant difference among the preservice science teachers' metacognitive awareness levels in terms of gender?

3) Is there a significant difference among the preservice science teachers' metacognitive awareness levels in terms of class levels?

## 3. Methods

### 3.1. Research Design

This study is descriptive in nature and the survey method was used to determine the metacognitive awareness levels of preservice science teachers within the quantitative research approach. In particular, survey method is a research approach that aims to describe a situation that existed in the past or still existing as it is (Cohen & Manion, 1994).

### 3.2 Participants

The sample of this study consisted of 188 preservice teachers enrolled in the undergraduate program of science teaching in a large, urban, public university in the northwestern Turkey. About, 24% of the sample were freshmen, with 29% sophomores, 20% juniors, and 27% seniors. Additionally, 82% of them consisted of female and the mean age of the sample was 20 years (SD=1.38, range 18 to 25 years).

### 3.3 Data Collection

Data for the study were collected by utilizing the Personal Information Form, and the Metacognitive Awareness Inventory. Data collection lasted approximately 35 minutes and it was performed in a classroom environment. All preservice science teachers participated in the study on a voluntary basis and were assured that their responses to the instruments would be anonymous and confidential.

### 3.4 Instruments

*3.4.1. Personal Information Form (PIF)*

The PIF was used the collect detailed information about preservice science teachers concerning age, gender, grade level, and science background so that their responses to the Metacognitive Awareness Inventory could be better comprehended.

*3.4.2. Metacognitive Awareness Inventory (MAI)*

The MAI developed by Schraw & Dennison (1994) and adapted into Turkish by Akin, Abaci, & Cetin (2007) was used to determine the metacognitive awareness levels of preservice science teachers. This inventory is a 52-item scale that all of the items are rated on a 5-point Likert scale, ranging from 1 'Never' to 5 'Always', including eight sub-components (declarative knowledge, procedural knowledge, conditional knowledge, monitoring, planning, evaluation, debugging, information management), grouped under two main components (knowledge of cognition and regulation of cognition). In particular, declarative knowledge, procedural knowledge, conditional knowledge sub-components derived from the knowledge of cognition component, while monitoring, planning, evaluation, debugging, information management came within the regulation of cognition component (Schraw & Dennison, 1994).

Knowledge about cognition component contains 17 items, and measures an awareness of one's strengths and weaknesses, knowledge about strategies, and why and when to use those strategies. Regulation of cognition component includes 35 items, and measures knowledge about planning, implementing, monitoring, and evaluating strategies. Additionally, the MAI does not contain any negative items, and the highest score that can be obtained from this inventory is 260, and the lowest score is 52. High scores obtained from the inventory show high levels of metacognitive awareness. By dividing the total score taken from the inventory (52), it was deemed that the individuals who took a score below 2.50 from MAI have low, and those who took a score above it have a high metacognitive awareness level (Akin, Abaci, & Cetin, 2007).

The Cronbach's alpha internal consistency coefficient was calculated as .96 for the original version of the MAI (Schraw & Dennison, 1994), and it was calculated as .95 for the Turkish version of the MAI (Akin, Abaci, & Cetin, 2007). Cronbach's alpha coefficient for the MAI was calculated as .96 for the data obtained from this study. In particular, they were calculated as .92 for the knowledge of cognition, and .94 for the regulation of cognition components.

### 3.5 Data Analysis

In order to determine metacognition awareness levels of preservice science teacher's descriptive statistical analysis was applied. In particular, mean, standard deviation, independent samples t-test, one-way analysis of variance (ANOVA) and Tukey's test were calculated. Statistical analyses of the study were performed using the PASW Statistics 18, a statistical package from SPSS Inc., California, USA. For all of the statistical decoding, the significance level was determined as .05.

## 4. Results

The descriptive statistics for the MAI scores are presented in Table 1.

**Table 1:** Descriptive statistics for MAI

| MAI components | N | Min | Max | $\bar{X}$ | SD |
|---|---|---|---|---|---|
| **Knowledge of cognition** | 188 | 2.76 | 5.00 | 3.88 | .45 |
| Declarative knowledge | 188 | 2.88 | 5.00 | 3.92 | .51 |
| Procedural knowledge | 188 | 2.25 | 5.00 | 3.84 | .58 |
| Conditional knowledge | 188 | 2.60 | 5.00 | 3.93 | .56 |
| **Regulation of cognition** | 188 | 2.66 | 5.00 | 3.86 | .47 |
| Planning | 188 | 2.14 | 5.00 | 3.79 | .63 |
| Monitoring | 188 | 2.50 | 5.00 | 3.80 | .53 |
| Evaluation of learning | 188 | 2.33 | 5.00 | 3.71 | .52 |
| Debugging strategies | 188 | 2.60 | 5.00 | 3.99 | .52 |
| Information management | 188 | 2.56 | 5.00 | 3.88 | .47 |
| **MAI Total** | **188** | **2.69** | **5.00** | **3.84** | **.43** |

As seen in Table 1, preservice science teachers' metacognitive awareness levels were found high in terms of total mean score ($\bar{X}$ = 3.84). Considering the mean scores it was obvious that preservice science teachers have high level of awareness in terms of knowledge of cognition ($\bar{X}$ = 3.88) and regulation of cognition ($\bar{X}$ = 3.86) main components. Upon examining the sub-components under the knowledge of cognition component, mean scores obtained from the declarative knowledge ($\bar{X}$ = 3.92) and conditional knowledge ($\bar{X}$ = 3.93) sub-components were found higher than the procedural knowledge ($\bar{X}$ = 3.84) sub-component. And, considering the regulation of cognition component, the highest mean score was obtained from the debugging ($\bar{X}$ = 3.99), and the lowest mean score was obtained from the evaluation ($\bar{X}$ = 3.71) sub-component.

The distribution of the metacognitive awareness levels of the preservice science teachers in terms of gender is presented in Table 2.

**Table 2:** Distribution of the metacognitive awareness levels of preservice science teachers in terms of gender

| Metacognitive awareness | Gender | | | | Total | |
|---|---|---|---|---|---|---|
| | Female | | Male | | | |
| | f | % | f | % | f | % |
| High | 155 | 82.4% | 33 | 17.6% | 188 | 100% |
| Low | - | - | - | - | - | - |
| **Total** | **155** | **82.4%** | **33** | **17.6%** | **188** | **100%** |

As stated before, preservice science teachers' MAI scores were grouped as low (range 0-2.49), and high (2.50-5.00). According to the results as presented in Table 2, all of the preservice science teachers (100.00%) were specified as having a high level of metacognitive awareness.

In order to investigate the differences between the gender of the preservice science teachers and the levels of their metacognitive awareness, the knowledge of cognition and regulation of cognition components, a t-test was applied for independent groups and the results are presented in Table 3.

**Table 3:** Independent samples t-test results of the components of MAI in terms of gender

| MAI components | Gender | N | $\bar{X}$ | SD | t | df | p |
|---|---|---|---|---|---|---|---|
| Knowledge of cognition | Female | 155 | 3.88 | .43 | .358 | 186 | .721 |
| | Male | 33 | 3.85 | .54 | | | |
| Regulation of cognition | Female | 155 | 3.88 | .44 | 1.141 | | .759 |
| | Male | 33 | 3.77 | .60 | | | |
| **MAI Total** | Female | 155 | 3.85 | .40 | .768 | | .443 |
| | Male | 33 | 3.79 | .55 | | | |

As seen in Table 3, total mean scores obtained by female preservice science teachers ($\bar{X}$ = 3.85) from MAI are higher than those of male preservice science teachers ($\bar{X}$ = 3.79). However, this difference is not statistically significant ($t_{total\ (186)}$ = .768; p > .05). Besides, it was determined that mean scores on the knowledge of cognition and regulation of cognition components do not differ by the gender of preservice science teachers ($t_{knowledge\ of\ cognition\ (186)}$ = .358, $t_{regulation\ of\ cognition\ (186)}$ = 1.141; p > .05). Accordingly, Table 4 shows the t-test results of the MAI sub-components in terms of gender. As seen in Table 4, the mean scores of both female and male preservice science teachers on the declarative knowledge ($\bar{X}_{females}$= 3.93; $\bar{X}_{males}$= 3.89) and conditional knowledge ($\bar{X}_{females}$= 3.94; $\bar{X}_{males}$= 3.88) sub-components were found higher than the procedural knowledge sub-component ($\bar{X}_{females}$= 3.85; $\bar{X}_{males}$= 3.83) under the knowledge of cognition component. Nevertheless, despite the fact that the mean scores of female preservice science teachers are higher than the mean scores of male preservice science teachers, it was determined that there is no statistically significant difference in declarative knowledge, procedural knowledge and conditional knowledge sub-components in terms of gender ($t_{declarative\ knowledge\ (186)}$ = .479, $t_{procedural\ knowledge\ (186)}$ = .189, $t_{conditional\ knowledge\ (186)}$ = .522; p > .05). And while female preservice science teachers obtained the highest mean score in debugging ($\bar{X}_{females}$= 4.05), and the lowest mean score in the evaluation sub-component ($\bar{X}_{females}$= 3.71), the highest mean score of male preservice teachers is in information management

($\bar{X}_{males}$= 3.78) and the lowest mean score is in the planning sub-component ($\bar{X}_{males}$= 3.67) under the regulation of cognition component. In addition, statistically significant differences were determined in debugging sub-component ($t_{debugging\ (186)}$ = 3.118; $p < .05$) in favor of female preservice science teachers, while there is no significant difference in planning, monitoring, evaluation and information management sub-components. Accordingly, it can be said that the debugging awareness of female preservice science teachers is higher than male preservice science teachers.

**Table 4:** Independent samples t-test results of the sub-components of MAI in terms of gender

| | MAI sub-components | Gender | N | $\bar{X}$ | SD | t | df | p |
|---|---|---|---|---|---|---|---|---|
| Knowledge of cognition | Declarative knowledge | Female | 155 | 3.93 | .49 | .479 | 186 | .632 |
| | | Male | 33 | 3.89 | .57 | | | |
| | Procedural knowledge | Female | 155 | 3.85 | .55 | .189 | | .850 |
| | | Male | 33 | 3.83 | .72 | | | |
| | Conditional knowledge | Female | 155 | 3.94 | .54 | .522 | | .602 |
| | | Male | 33 | 3.88 | .61 | | | |
| Regulation of cognition | Planning | Female | 155 | 3.82 | .60 | 1.295 | | .197 |
| | | Male | 33 | 3.67 | .74 | | | |
| | Monitoring | Female | 155 | 3.80 | .49 | .392 | | .695 |
| | | Male | 33 | 3.76 | .67 | | | |
| | Evaluation | Female | 155 | 3.71 | .48 | -.021 | | .983 |
| | | Male | 33 | 3.71 | .68 | | | |
| | Debugging | Female | 155 | 4.05 | .49 | 3.118 | | .002* |
| | | Male | 33 | 3.74 | .58 | | | |
| | Information management | Female | 155 | 3.90 | .45 | 1.274 | | .204 |
| | | Male | 33 | 3.78 | .57 | | | |

*p< .05

The distribution of the metacognitive awareness levels of the preservice science teachers in terms of grade level is presented in Table 5. As stated before, preservice science teachers' MAI scores were grouped as low (range 0-2.49), and high (2.50-5.00). According to the results as presented in Table 5, all grades of the preservice science teachers (100.0%) were specified as having a high level of metacognitive awareness.

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**Table 5:** Distribution of the metacognitive awareness levels of preservice science teachers in terms of grade level

| Metacognitive awareness | Grade Levels | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Freshmen | | Sophomores | | Juniors | | Seniors | | | |
| | f | % | f | % | f | % | f | % | f | % |
| High | 45 | 23.9% | 54 | 28.7% | 38 | 20.2% | 51 | 27.1% | 188 | 100% |
| Low | - | - | - | - | - | - | - | - | - | - |
| **Total** | 45 | 23.9% | 54 | 28.7% | 38 | 20.2% | 51 | 27.1% | 188 | 100% |

In order to investigate the differences between the grade level of the preservice science teachers and the levels of their metacognitive awareness, the knowledge of cognition and regulation of cognition components, a one-way ANOVA test was applied and the results are presented in Table 6. As seen in Table 6, senior preservice science teachers have the highest levels of awareness both in the MAI total ($\bar{X}_{seniors}$= 4.00) and in the main components (knowledge of cognition ($\bar{X}_{seniors}$= 4.02) and regulation of cognition ($\bar{X}_{seniors}$= 4.12)) of the MAI.

**Table 6:** One-way ANOVA test results of the components of MAI in terms of grade level

| MAI components | Grade levels | N | $\bar{X}$ | SD |
|---|---|---|---|---|
| Knowledge of cognition | 1 | 45 | 3.83 | .43 |
| | 2 | 54 | 3.81 | .46 |
| | 3 | 38 | 3.84 | .43 |
| | 4 | 51 | 4.02 | .43 |
| Regulation of cognition | 1 | 45 | 3.72 | .42 |
| | 2 | 54 | 3.80 | .45 |
| | 3 | 38 | 3.74 | .41 |
| | 4 | 51 | 4.12 | .49 |
| **MAI Total** | 1 | 45 | 3.76 | .41 |
| | 2 | 54 | 3.81 | .44 |
| | 3 | 38 | 3.77 | .41 |
| | 4 | 51 | 4.00 | .43 |

Accordingly, Table 7 shows the one-way ANOVA results of the MAI sub-components in terms of grade level.

**Table 7:** One-way ANOVA test results of the sub-components of MAI in terms of grade level

| | MAI sub-components | Grade levels | N | $\bar{X}$ | SD |
|---|---|---|---|---|---|
| Knowledge of cognition | Declarative knowledge | 1 | 45 | 3.85 | .44 |
| | | 2 | 54 | 3.81 | .49 |
| | | 3 | 38 | 3.85 | .47 |
| | | 4 | 51 | 4.16 | .53 |
| | Procedural knowledge | 1 | 45 | 3.74 | .57 |
| | | 2 | 54 | 3.76 | .54 |
| | | 3 | 38 | 3.74 | .55 |
| | | 4 | 51 | 4.09 | .58 |
| | Conditional knowledge | 1 | 45 | 3.87 | .55 |
| | | 2 | 54 | 3.85 | .52 |
| | | 3 | 38 | 3.89 | .49 |
| | | 4 | 51 | 4.09 | .62 |
| Regulation of cognition | Planning | 1 | 45 | 3.62 | .56 |
| | | 2 | 54 | 3.70 | .59 |
| | | 3 | 38 | 3.65 | .49 |
| | | 4 | 51 | 4.15 | .69 |
| | Monitoring | 1 | 45 | 3.73 | .50 |
| | | 2 | 54 | 3.72 | .54 |
| | | 3 | 38 | 3.71 | .47 |
| | | 4 | 51 | 4.00 | .52 |
| | Evaluation | 1 | 45 | 3.52 | .46 |
| | | 2 | 54 | 3.70 | .55 |
| | | 3 | 38 | 3.71 | .45 |
| | | 4 | 51 | 3.89 | .53 |
| | Debugging | 1 | 45 | 3.99 | .49 |
| | | 2 | 54 | 3.96 | .55 |
| | | 3 | 38 | 3.95 | .50 |
| | | 4 | 51 | 4.07 | .53 |
| | Information management | 1 | 45 | 3.78 | .47 |
| | | 2 | 54 | 3.94 | .46 |
| | | 3 | 38 | 3.75 | .48 |
| | | 4 | 51 | 4.00 | .45 |

As seen in Table 7, the highest mean scores are obtained by senior preservice science teachers in all sub-components ($\bar{X}_{\text{declarative knowledge}} = 4.16$; $\bar{X}_{\text{procedural knowledge}} = 4.09$; $\bar{X}_{\text{conditional knowledge}} = 4.09$; $\bar{X}_{\text{planning}} = 4.15$; $\bar{X}_{\text{monitoring}} = 4.00$; $\bar{X}_{\text{evaluation}} = 3.89$; $\bar{X}_{\text{debugging}} = 4.07$; $\bar{X}_{\text{information management}} =$

4.00). In particular, senior preservice science teachers obtained the highest mean scores from declarative knowledge sub-component. However, it was determined that freshman, sophomore, and junior preservice science teachers obtained the highest mean scores from the conditional knowledge sub-component ($\bar{X}_{freshmen}$= 3.87; $\bar{X}_{sophomores}$= 3.85; $\bar{X}_{juniors}$= 3.89) and the lowest from the procedural knowledge sub-component ($\bar{X}_{freshmen}$= 3.74; $\bar{X}_{sophomores}$ = 3.76; $\bar{X}_{juniors}$ = 3.74) under the knowledge of cognition component.

When it comes to the regulation of cognition component, the highest mean scores of freshman, sophomore, and junior preservice science teachers are in debugging sub-component ($\bar{X}_{freshmen}$= 3.99; $\bar{X}_{sophomores}$= 3.96; $\bar{X}_{juniors}$= 3.95) while seniors had the highest mean score in the planning sub-component ($\bar{X}_{seniors}$= 4.15). On the other hand, the lowest mean score of freshman and senior preservice science teachers is in the evaluation sub-component ($\bar{X}_{freshmen}$= 3.52; $\bar{X}_{seniors}$ = 3.89), and it's in the planning sub-component for juniors ($\bar{X}_{juniors}$= 3.65). And also, the mean scores obtained by senior preservice science teachers in planning ($\bar{X}_{planning}$= 3.70), monitoring ($\bar{X}_{monitoring}$= 3.72) and evaluation ($\bar{X}_{evaluation}$= 3.70) sub-components were found lower than debugging ($\bar{X}_{debugging}$= 3.96) and information management ($\bar{X}_{information\ management}$= 3.94) sub-components.

ANOVA and Tukey's tests results of preservice science teachers on the knowledge of cognition and the regulation of cognition components with their total metacognitive awareness levels in terms of grade level variable are shown in Table 8.

**Table 8:** ANOVA and Tukey's tests results of the components of t MAI in terms of grade level

| **MAI components** | **Source of variance** | **Sum of squares** | **df** | **Mean squares** | **F** | **p** | **Sig. dif.** |
|---|---|---|---|---|---|---|---|
| Knowledge of cognition | Between-groups | 1.417 | 3 | .472 | 2.413 | .068 | - |
| | Within-groups | 36.014 | 184 | .196 | | | |
| | Total | 37.431 | 187 | | | | |
| Regulation of cognition | Between-groups | 5.024 | 3 | 1.675 | 8.304 | .000 | 1-4<br>2-4<br>3-4 |
| | Within-groups | 37.107 | 184 | .202 | | | |
| | Total | 42.131 | 187 | | | | |
| **MAI Total** | Between-groups | 1.823 | 3 | .608 | 3.414 | .019* | 1-4 |
| | Within-groups | 32.758 | 184 | .178 | | | |
| | Total | 34.581 | 187 | | | | |

p<.05

As it seen in Table 8, a statistically significant difference was determined between the metacognitive awareness total scores of freshman and senior preservice science teachers in favor of seniors ($F_{(3-184)} = 3.414$; $p < .05$). In this direction, it can be expressed that the metacognitive awareness levels of senior preservice science teachers are higher than the metacognitive awareness levels of freshman preservice science teachers. When the main components were examined, even no significant difference was found in terms of the knowledge of cognition ($F_{(3-184)}= 2.413$; $p > .05$), a statistically significant difference was determined in terms of the regulation of cognition between senior preservice science teachers and all other grade levels in favor of senior preservice science teachers ($F_{(3-184)}= 8.304$; $p < .05$). Accordingly, it can be said that metacognitive awareness levels of senior preservice science teachers on regulation of cognition are higher than all other grade levels.

ANOVA and Tukey's tests results of the MAI sub-components in terms of grade level of preservice science teachers are shown in Table 9. As seen in Table 9, in considering the knowledge of cognition main component, even there is no significant difference in the conditional knowledge sub-component ($F_{\text{conditional knowledge } (3-184)} = 1.882$; $p >.05$) in terms of the grade level, significant differences were detected in declarative knowledge ($F_{\text{declarative knowledge } (3-184)}= 5.653$; $p<.05$) and procedural knowledge ($F_{\text{procedural knowledge}(3-184)}= 4.619$; $p <.05$) sub-components between senior preservice science teachers and all other grade levels in favor of senior preservice science teachers. Besides, considering the regulation of cognition main component, a statistically significant difference was detected in declarative knowledge ($F_{\text{declarative knowledge}(3-184)} = 5.653$; $p<.05$) and procedural knowledge ($F_{\text{procedural knowledge } (3-184)}= 4.619$; $p<.05$) sub-components between senior preservice science teachers and all other grade levels in favor of senior preservice science teachers. However, no significant difference was detected in the debugging sub-component ($F_{\text{debugging } (3-184)}= .602$; $p>.05$).

ANOVA and Tukey's tests results of the MAI sub-components in terms of grade level of preservice science teachers are shown in Table 9. As seen in Table 9, considering the knowledge of cognition main component, even there is no significant difference in the conditional knowledge sub-component ($F_{\text{conditional knowledge } (3-184)}= 1.882$; $p >.05$) in terms of grade level, a significant difference was detected in declarative knowledge ($F_{\text{declarative knowledge } (3-184)}= 5.653$; $p<.05$) and procedural knowledge ($F_{\text{procedural knowledge}(3-184)}= 4.619$; $p<.05$) sub-components between senior preservice science teachers and all other grade levels in favor of seniors. Besides, considering regulation of cognition main component, a statistically significant difference was detected in planning ($F_{\text{planning } (3-184)} = 8.450$; $p<.05$) and monitoring ($F_{\text{monitoring } (3-184)} = 3.967$; $p<.05$) sub-components between senior preservice science teachers and all other grade levels in favor of seniors. Accordingly, it can be expressed that the metacognitive awareness levels of senior preservice science teachers on declarative, procedural knowledge, planning and monitoring strategies are higher than all other grade levels. In addition, even no significant difference was detected in the debugging ($F_{debugging\ (3\text{-}184)}$= .602; p>.05) sub-component in terms of the grade level, a significant difference was detected in evaluation ($F_{evaluation\ (3\text{-}184)}$= 4.078; p<.05) sub-component between senior preservice science teachers and freshman preservice science teachers in favor of seniors. And also, a statistically significant difference was detected in information management ($F_{information\ management\ (3\text{-}184)}$= 3.160; p<.05) sub-component, between senior preservice science teachers and freshman and junior preservice science teachers in favor of seniors.

**Table 9:** ANOVA and Tukey's tests results of the sub-components of MAI in terms of grade level

| | MAI Sub-components | Source of variance | Sum of squares | df | Mean squares | F | p | Sig.dif. |
|---|---|---|---|---|---|---|---|---|
| Knowledge of cognition | Declarative Knowledge | Between-groups | 4.058 | 3 | 1.353 | 5.653 | .001 | 1-4<br>2-4<br>3-4 |
| | | Within-groups | 44.022 | 184 | .239 | | | |
| | | Total | 48.079 | 187 | | | | |
| | Procedural Knowledge | Between-groups | 4.394 | 3 | 1.465 | 4.619 | .004 | 1-4<br>2-4<br>3-4 |
| | | Within-groups | 58.352 | 184 | .317 | | | |
| | | Total | 62.746 | 187 | | | | |
| | Conditional Knowledge | Between-groups | 1.725 | 3 | .575 | 1.882 | .134 | - |
| | | Within-groups | 56.216 | 184 | .306 | | | |
| | | Total | 57.941 | 187 | | | | |
| Regulation of cognition | Planning | Between-groups | 9.020 | 3 | 3.007 | 8.450 | .000 | 1-4<br>2-4<br>3-4 |
| | | Within-groups | 65.471 | 184 | .356 | | | |
| | | Total | 74.492 | 187 | | | | |
| | Monitoring | Between-groups | 3.152 | 3 | 1.051 | 3.967 | .009* | 1-4<br>2-4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Within-groups | 48.729 | 184 | .265 | | | 3-4 |
| | Total | 51.882 | 187 | | | | |
| Evaluation | Between-groups | 3.152 | 3 | 1.051 | | | |
| | Within-groups | 47.415 | 184 | .258 | 4.078 | .008* | 1-4 |
| | Total | 50.567 | 187 | | | | |
| Debugging | Between-groups | .510 | 3 | 10.170 | | | |
| | Within-groups | 50.408 | 184 | .274 | .621 | .602 | - |
| | Total | 50.918 | 187 | | | | |
| Information Management | Between-groups | 2.036 | 3 | .679 | | | |
| | Within-groups | 39.525 | 184 | .215 | 3.160 | .026* | 1-4 3-4 |
| | Total | 41.561 | 187 | | | | |

*p<.05

## 5. Conclusion and Discussion

In this study that aims first to determine the metacognitive awareness levels of preservice science teachers, the metacognitive awareness levels of preservice science teachers were generally found high. This result obtained from the study overlaps with the study results of Alci and Karatas (2011), Alkan and Erdem (2014), Bedel (2012), Deniz, Kucuk, Cansiz, Akgun, and Isleyen (2014), Gul, Ozay-Kose, and Sadi-Yilmaz (2015), Memnun and Akkaya (2012), Sapanci (2012), Young and Fry (2008). Similarly, preservice science teachers' perception levels towards metacognition were found high in the study of Mai (2015). However, metacognitive awareness levels of freshmen were found low in the study carried out by Sperling, Howard, Staley and DuBois (2004). Also, in the study of Yesilyurt (2013), it was determined that the levels of using metacognitive learning strategies of university students were at the intermediate level.

In consideration of the main components, it was determined that mean scores obtained by preservice science teachers both from knowledge of cognition and regulation of cognition were also found high. Accordingly, it can be said that the knowledge levels of preservice science teachers on their cognitive systems and their levels of using strategies in order to control their cognitions were high. There are some studies supporting this result in the literature (Alkan & Erdem, 2014; Kállay, 2012; Young & Fry, 2008). When the sub-components of the knowledge of cognition component were addressed, mean scores obtained by preservice science teachers both from declarative knowledge and conditional knowledge were found higher than procedural knowledge. According to this result, it can be expressed that the knowledge level of preservice science teachers on strategies and methods are lower when compared to their knowledge and knowledge level of why and when to use a particular strategy and method on themselves, as learners. The reason for this can be that preservice teachers do not allocate enough space to activities that require them to use different strategies and methods. Consequently, it was determined in the works of Sungur and Senler (2009) that students who deal with challenging tasks become metacognitively more active. When the sub-components of the regulation of cognition component were addressed, it is seen that preservice teachers have the highest scores in the debugging and the lowest score in evaluation. Glaser, Chudowsky, and Pellegrino (2001) indicated that while successful learners prefer to try a different strategy when a strategy does not work, unsuccessful learners stick to a particular strategy even the strategy does not yield the required output. In this direction, the fact that the highest score is taken in debugging sub-component can reflect that preservice science teachers use strategies aimed at correcting conception and performance errors in their learning process. As the lowest score is taken in the evaluation sub-component, it can be said that preservice teachers should further improve themselves in evaluating their learning.

When the metacognitive awareness levels of preservice science teachers were examined in terms of gender, it was determined that there is no statistically significant difference in terms of the total score obtained from the MAI. There are many studies that support this result in the literature (Alci & Karatas, 2011; Bakioglu, Kucukaydin, Karamustafaoglu, Ulucinar-Sagir, Akman, Ersanli, & Cakir, 2015; Cikrikci & Odaci, 2015; Deniz, Kucuk, Cansiz, Akgun, & Isleyen, 2014; Mai, 2015; Ozsoy & Gunindi, 2011; Sapanci, 2012; Sperling, Howard, Miller, & Murphy, 2002). However, the metacognitive awareness levels of female students were found higher than the metacognitive awareness levels of male students in the studies of Bogdanovic, Obadovic, Cvjeticanin, Segedinacve and Budic (2015) and Kilinc (2013). When the main components were taken into consideration, it was determined that there is no differentiation in the knowledge of cognition and regulation of cognition components by gender. And when the sub-components were examined, no significant difference was found in any sub-components under the knowledge of cognition component while a statistically significant difference was found in favour of female preservice science teachers in debugging under the regulation of cognition component. Accordingly, it can be expressed that the level of using strategies of preservice female science teachers in correcting the conception and performance errors they encounter in the process of learning was higher when compared to male preservice science teachers. However, the scores obtained by both preservice female teachers and male teachers from the declarative knowledge and conditional knowledge sub-components were close to each other and higher than the procedural knowledge sub-component. Whereas, it is seen that female preservice science teachers obtained the highest score under the regulation of cognition component from debugging sub-component, and the lowest score from the evaluation sub-component, while male preservice science teachers obtained the highest score from information management sub-component, and the lowest score from planning sub-component. What is striking is that while female and male preservice science teachers were similar in terms of their knowledge of cognition, they were differing in terms of the strategies used in the regulation of cognition. This consequence may result from the tendency to differentiate in using regulation of cognition skills by learners; even they show a similar tendency in using the knowledge about cognition, as specified by Schraw (1994).

When the metacognitive awareness levels of preservice science teachers were examined in terms of grade level, a statistically significant difference was determined between freshman and senior preservice teachers in favor of senior preservice teachers in terms of the total score obtained from the MAI. Accordingly, it can be expressed that the metacognitive awareness levels of senior preservice science teachers are higher than freshmen. This consequence can be interpreted as that undergraduate education contributes to the metacognitive awareness of preservice teachers. Similarly, in the study of Memnun and Akkaya (2012), it was determined that the metacognitive awareness levels of sophomore and senior preservice teachers are higher than the awareness levels of freshmen. And in the study of Ozsoy and Gunindi (2011), metacognitive awareness levels of senior preservice teachers were found higher than sophomores. However, in the study of Sapanci (2012), it was detected that there is no statistically significant difference between freshman and senior preservice teachers. Also, in the studies carried out by Deniz, Kucuk, Cansiz and Isleyen (2014) and Gul, Ozay-Kose, and Sadi-Yilmaz (2015), it was detected that there is no statistically significant difference in terms of grade levels. When the main components were taken into consideration, it was determined that no statistically significant difference was found in the knowledge of cognition component, while there is a significant difference between senior preservice science teachers and all other grade levels in the regulation of cognition component in favor of senior preservice teachers. When the sub-components were examined, no significant difference was found in the conditional knowledge under the knowledge of cognition component, while a statistically significant difference was found in declarative and procedural knowledge levels of senior preservice science teachers were found higher than of the preservice teachers of all other grade levels. Considering the regulation of cognition component, it was determined that there is no significant difference by grade level in the debugging sub-component. However, the levels of using planning and monitoring strategies by senior preservice science teachers were found higher than the preservice teachers of all other grade levels. Furthermore, statistically significant differences were determined between freshman preservice science teachers and senior preservice science teachers in evaluation sub-component, and between junior preservice science teachers and senior preservice science teachers in information management sub-component in favor of senior preservice teachers. Similarly, in the studies of Hamurcu (2002) and Yesilyurt (2013), it was found that the levels of using learning strategies by preservice teachers differ by grade levels.

## 6. Implications

Based on the results obtained from this study it can be suggested that teacher training programs should be arranged in such a way that promote preservice teachers' metacognitive knowledge and skills totally as well as in relation to each other. Additionally, practical lessons in which metacognitive knowledge and skills are learnt easily can be offered. In the study, procedural knowledge levels of preservice teachers were found lower than other knowledge levels considering the knowledge of cognition component. So, lessons can be arranged in such a way that requires preservice teachers to use different strategies and methods. Similarly, the levels of using the evaluation strategy by preservice science teachers were found lower than other strategies considering the regulation of cognition component. Accordingly, activities that aim to evaluate both preservice teachers themselves and their friends should be included in the learning process. Overall, the survey method was used in the study. The validity of the study can be increased by using qualitative research methods that examine the metacognitive awareness levels of preservice science teachers in-depth.

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