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Full Length Research Paper

The effect of metacognition strategy teaching on biology education

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ABSTRACT

The development of students' skills of using metacognition and their comprehension level of "Classification of Living Beings and Conscious Individual - Habitable Environment" were examined through teaching metacognitive strategies to the students. The study aims to determine whether there is a significant relationship between the score changes on the achievement scale and the use of metacognitive strategies in the classes in which metacognitive strategies are applied. The research is an experimental study using the "control group pre-post test model". 60 students were studied in the experimental and control groups. Two classes whose success levels are close to each other were selected among the students aged 14-15 who were educated in the same school. It was determined by the pretest that the success levels of these two classes and their knowledge of using metacognitive strategies were similar. Prior to the study, the Motivated Strategies for Learning Questionnaire and the Achievement Scale were applied to the two classes. Classical lectures were made in the control group for 13 weeks. In the experimental group, the lesson was taught by applying metacognitive strategies. After the lesson process, the same questionnaires were applied as a post-test. Pre and post-test results were compared and interpreted. In addition, the relationship between the results of the two surveys was evaluated. As a result, the achievement test and GÖS Scale scores of the students whose pre and post-tests were evaluated changed significantly in a positive way. In addition, in the light of the findings, it was determined that the students with high scores of using metacognitive techniques had the highest average on the achievement scale.

Keywords: Metacognition, biology education, educational strategies.

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INTRODUCTION

Biology science is a branch of science that deals with the structure and diversity of living things, the basic life events that take place in their bodies, their growth and development, their behavior, their relationships with each other and their environment, and their distribution on the earth (Güven et al., 2001).

Biology examines each living species specifically and draws conclusions that people can benefit from these studies. These results sometimes lead to the emergence of new technologies and sometimes an innovation in medicine (Yaman and Soran, 2000).

It is known that there are several million species of life on earth today. In addition, this number is constantly increasing in new species found. For this reason, it takes a meaningless effort to observe, examine, and define separately the creatures whose number exceeds millions. It is necessary to divide large groups into small groups in order to obtain sufficient information about living things. Classification (= taxonomy), one of the sub-disciplines of biology, is defined as separating living things into groups according to their characteristics (Güven et al., 2001). Classification and naming are very important. Because taxonomy requires thousands of scientists to get along with each other over certain concepts and to be able to explain the same thing to each other, even if they speak in different languages. For this reason, every living thing

needs to be classified and named within a certain system. The subject of classification of living things is an important issue given in the "Classification of Living Beings and Conscious Individual - Habitable Environment" unit in the 1st grade of high school in Turkey. It is important to learn the unit effectively.

Basic science and modern technology based on them are rapidly developing our world. It is seen that this development and change affects human life, the world's thinking system and cultural life. For our young people to be educated in a way that they can adapt and contribute to these changes, all teaching methods should be reviewed by taking into account the changing conditions and needs. (Kılıç Çakmak et al., 2008).

In today's education system, the main goal is to provide our students with the ability to access information instead of transferring existing information as it is. This happens with high-level mental processing skills. In other words, learning by comprehension, solving problems related to new situations and scientific method process rather than memorization requires skills (Kuhn, 2000).

When evaluating studies in biology teaching in Turkey, high school teachers do not have enough opportunities to use different teaching techniques, biology teachers often have been determined to use using traditional teaching methods during classes (Atılboz, 2001; Atıcı and Doğan, 2004; Akkurt, 2020). According to the surveys applied to biology teachers in various high schools selected in Ankara, it has been revealed that applied teaching methods and techniques are not used sufficiently in biology lessons in high schools, and the opportunities of biology teachers in high schools are not sufficient. (Akaydın and Soran, 1998; Yaman and Soran, 2000).

In our constantly developing world, education systems are constantly being renewed. Our teachers, who are effective in raising future generations in a way that can adapt to the developments in the world, should provide the necessary learning environment for them to reach the knowledge themselves and apply what they have learned, instead of providing them with the theoretical knowledge. Based on this point, we tried to explain the subject of classification with metacognitive strategies, which is a different educational strategy, and the student can learn by evaluating himself, based on quantitative data, in our study.

The concept of metacognition

The concept of metacognition has been defined differently by different researchers. Originally called "metacognition" concept, 'cognitive knowledge', 'beyond cognition', 'metacognitive knowledge', 'executive cognition' (Senemoğlu 2007), 'metacognitive', 'way of using information', 'cognitive awareness' (Gelen, 2004), And this term is translated into our language as 'metacognition' Özsoy (2007). As a result of the correspondence with the Turkish Language Association during Özsoy (2007) study, the translation of the term Metacognition into our language as 'Metacognition' was deemed appropriate by the Turkish Language Association. In this study, it was found appropriate to use the term 'metacognition' as metacognition.

Metacognition is defined as thinking about thinking, knowing what he knows and does not know. (Livingston, 2003; Blakey and Spence, 1990; Flavell, 1979). While cognition is being aware of and understanding information, metacognition is knowing how or by which technique is learned in addition to learning and understanding information (Wall and Higgins, 2006). Metacognition includes consciously structuring and storing the data, analyzing the information in the memory and retrieving the necessary information from the memory and being aware of this stored information (Flavell, 1979). D'avanzo (2003), while using metacognitive strategies in his study, displayed the following point of view: "Thinking about them, not just theories".

Components of metacognition have been studied in different dimensions by different researchers. However, research on metacognition generally focuses on two main components. These are the knowledge of cognition and the regulation of cognition (Sperling et al., 2004; Flavell, 1979; Schraw and Graham, 1997). Knowledge of cognition expresses how much learners learn with their own memory and learning methods. Regulation of cognition includes how learners organize their own learning (Gelen, 2004). Metacognition, according to O'Neil and Abedi (1996), involves planning, self-control, cognitive strategies and awareness.

The concept of metacognition is that students should not just simply know what the subject is, but think about it. It is the individual's own cognitive skills, the functioning of his skills, and thinking about the points he knows and does not know. According to these, it is knowing when and how he uses the metacognitive strategies. It is the accurate analysis of data and processing by associating it with long-term memory and retrieving it from memory completely and accurately when necessary.

In the literature, metacognitive strategies are thought to be one of the important factors in increasing the success of individuals (Schraw, 2009; Deseote et al., 2001; Lin et al., 2005; Kuiper, 2002; Yurdakul and Demirel, 2011). For metacognitive awareness, different strategies were emphasized, such as explaining metacognitive skills, teaching by structuring the course, teaching using various strategies and techniques, and teaching with cooperative learning techniques (Paris and Winogard, 1990). The most important strategy for teaching metacognitive skills is on the individual. The individual knows best how to learn concepts and how to relate the information network. Educators only guide students in this process. Students

who can organize knowledge are also individuals who know their strengths and weaknesses in learning (Yurdakul and Demirel, 2011).

To learn metacognitive strategies means that an individual follows the learning processes by recognizing himself and being aware of how he/she will learn (Duman, 2008; Doğan, 2013). It is observed that older children use the metacognitive strategies, which are observed to be developed around the age of 5-7, more effectively. It has been determined that when young children are given instructions on using strategies and reminded to use them, their learning level increases (Senemoğlu, 2007: 336). His study comparing verbal and nonverbal indicators of children's metacognitive skills showed that 138 subjects aged 5-6 years used metacognitive strategies with different ease. In addition, relational learning awareness was compared according to cognitive ability (Roebers et al., 2020). In a study where interdisciplinary studies were collected (Akkurt, 2020), he used metacognitive strategies in workshops of different disciplines to gain environmental awareness.

In the light of the investigations examined, since the emergence of metacognitive strategies, strategy education has been designed and implemented mostly for primary and secondary school students. Although this is applied to the level of knowledge and strategy, they can be used for advanced learners. In general, metacognitive strategies, whose effects on language, history and mathematics education were examined, were also examined in our study.

In his study, which is similar to our study in terms of content, D'avanzo (2003) enabled students to make inferences by choosing sections from Ecology books. He worked on making inferences from one scale to another. The students made evaluations by using the book named 'Marine Ecology Processes'. For example, can we estimate the live content of the Pacific from a liter of water sample? Or, can we make predictions about the 200 km long water system based on the number of living things of a 1 km long water system?

The following strategies are suggested to improve metacognitive behaviors (Blakey and Spence, 1990; Duman, 2008; Doğan, 2013):

- Defining what I know and what I do not know about the topic
- Giving some terms about the subject and expressing his thoughts and thoughts about them
- Keeping a diary for the learning process
- Planning and Self-Regulation
- Choosing appropriate strategies by making student discussions on the thinking processes at the end of the activities.
- Evaluating your own learning process

The ability of the student to ask some questions about his/her own learning skills and get answers is considered metacognitive awareness. Every science discipline must sample the questions necessary for this awareness. While learning the subject of Classification (taxonomy), which is the subject of our research, we can list the sample questions that the student can ask himself as follows:

• What is my purpose in learning to classify living things?
• What kind of product is expected to reach when I learn?
• What do I know about classification?
• How much time do I need to learn about classification?
• What should I plan to learn about this topic in the most effective way; How should I go about it?
• How should I review and fix it to fix the flaws in my plan?
• When I make a mistake, how should I find my mistake?
• Is the product that I will obtain as a result of my learning process suitable for my expectations?
• How should I change my planning if it is not okay?

An individual who is aware of his cognitive skills, first of all, concentrates his attention on the subject he will learn and develops an appropriate attitude towards this subject. This concentration and attitude development enable the person to recognize his/her own awareness and to control the learning strategy. In this way, the person organizes himself, knows what state he is in, and can plan how he should move forward. He analyzes his plans and tries again. Then he realizes how much he learns, how he learns, what ways of thinking he follows, develops it, and turns these skills into a lifestyle.

METHOD

The problem question of our study is “There is an effect of teaching metacognitive strategies in biology education on the success of learning, ‘Classification of Living Beings and Conscious Individual - Habitable Environment,’ and their ability to use metacognitive strategies." Depending on our problem question, three sub-problems have been identified.

First sub-problem: There is a significant difference between the students in the classes where metacognitive strategies will be applied and the students in the classes where the traditional learning approach will be applied in terms of learning achievement.
Second sub-problem: There is a significant difference between the students in the classes where metacognitive strategies will be applied and the students in the classes where the traditional learning approach will be applied in terms of using metacognitive strategies.
Third sub-problem: There is a significant relationship between the changes in the scores of the students in the

classes in which metacognitive strategies are applied and their use of metacognitive strategies.

Universe and sample

The population of the study is the first grade high school students in the secondary schools aged 14-15 in Sakarya province. The sample consists of students in two grades of Pamukova Anatolian High School who are in the first grade of high school, selected from the secondary schools in Sakarya province, considering the quality of their education. The sample consists of 60 students.

Data collection tool

The research was conducted on the data obtained with the "Motivated Strategies for Learning Questionnaire" and the success scale. General information about these scales can be listed as follows:

• “Motivated Strategies for Learning Questionnaire”: This tool was first developed by Pintrich et al. (1991) to determine the motivation and learning strategies of university students. It was adapted by Kılıç Çakmak et al. (2008) for 12 to 18 year old students and it was determined to be valid by performing confirmatory factor analysis. The ISSS consists of Motivation scales with 31 items and Learning Strategies scales with 50 items. However, the results of the items related to metacognition were used in the learning strategies part of the scale.

• An achievement test was prepared by the researcher in order to measure the students' knowledge about the subject to be covered. The achievement test consists of 32 questions and the questions are arranged to be answered on a 5-point scale. As a result of the pilot application of the achievement test, the Cronbach alpha coefficient (Reliability coefficient) was found to be 0.83.

Operation

After the measurement tools to be used in the research were determined, the necessary documents were obtained from the Education Research and Development Department of the Ministry of Education through Gazi University Institute of Educational Sciences by the researcher. The scales were also examined by the Sakarya Provincial Directorate of National Education and application permission was obtained. Experimental and control groups were determined randomly.

- Class sizes and students' achievement levels were taken into account in the selection of the experimental and control groups.
- "Before starting the application of the research, the experimental group students were informed about" Metacognitive Strategies "and the features of these activities were introduced.
- "Achievement Scale" and "Motivation and Learning Strategies Scale" were applied to both groups as a pre-test in order to determine the equivalence of the experimental and control groups in terms of the level of knowledge and it was tested whether there was a difference in the characteristics to be determined by tests between the groups.
- The lessons in the control group were planned by the researcher in accordance with the traditional learning approach and were taught without using Metacognitive Strategies.
- In the experimental group, a 13-week lesson plan was prepared by considering the Metacognitive Strategies prepared and the subjects were taught by the researcher under the guidance of this plan.
- Weekly course hour of biology lesson in the first year of high school is 2 hours.
- "At the end of the thirteen-week application process," Achievement Scale "and" Motivation and Learning Strategies Scale ", which were applied as a pre-test, were applied as a post-test to the experimental and control group students.
- Pretest and posttest results were analyzed by statistical analysis.
- Analyzes were given in the findings section and comments were made on the results.

Data analysis

In this study, independent samples t-test, frequency distribution, were used for independent groups. Statistical analysis was obtained as follows. The "t-test" was used to determine whether the difference between the average success of both groups was significantly based on the scores obtained from the pre-test and post-test.

- Comparison of success scale results applied as pre and post-test between groups,
- Comparison of the results of the GÖS scale applied as a pre and post-test between the groups,
- The relationship between the results of the achievement scale applied as a post-test between the groups with the scores students got from the metacognitive scale.

RESULTS

Results of the success scale

Achievement test was applied to the experimental and control groups before starting the study. According to the

statistical analysis results of the t-test given in Table 1, it was observed that there was no statistically significant difference between the two groups in terms of the first tests of success since p > 0.05 (0.483 > 0.05). This result shows that the levels of both groups are close to each other in terms of success.

Data were obtained as a result of the post-test applied at the end of a 13-week course enriched with metacognitive strategies. According to the statistical analysis results given in Table 1 (since p < 0.05), it was observed that there was a statistically significant difference between the two groups in terms of success posttest.

It can be said that the students studying with metacognitive strategies learned better the concepts and events related to the units of "Classification of Living Beings and Conscious Individual - Habitable Environment". In other words, from the success test, it has been determined that students studying with metacognitive strategies increased more points than students studying with traditional methods. Therefore, it was observed that the activities prepared according to the metacognitive strategies made a significant contribution to the learning success of the students.

GÖS scale findings

According to the statistical analysis results given in Table 2, since the first p-value is 'p > 0.05' (0.909 > 0.05), it was observed that there was no statistically significant difference between the two groups in terms of the pre-tests of the chest scale. This result shows that the knowledge levels of both groups about metacognitive strategies are close to each other.

According to the statistical analysis results given in Table 2, the final p-value was found to be 0.000 (since the final p < 0.05). It was observed that there was a statistically significant difference between the two groups in terms of the posttest of the POE scale. This difference was that the students in the experimental group showed more points change. The fact that students who study with metacognitive strategies in the last GÖS scale get higher scores than students who study with traditional methods shows that students can acquire the desired competence.

Table 1. Statistical analysis of achievement scale pre and post-tests of control and experimental groups according to t-test.

Group	Number of subjects	First arithmetic mean	Final arithmetic mean	Initial p-value	Final p-value
Experiment group	30	9.33	19.23	0.483*	0.000*
Control group	30	9.27	14.27		

Table 2. Statistical analysis of GÖS pre and post-tests of control and experimental groups according to the t-test.

Group	Number of subjects	First arithmetic mean	Final arithmetic mean	Initial p value	Final p value
Experiment group	30	85.83	152	0.909*	0.000*
Control group	30	86.17	88.58		

Relationship between achievement scale and GÖS scale findings

The students were grouped according to their scores from the GÖS scale (such as 1, 2, 3) and the scores they got from the success scale with these results were subjected to independent sample one-way analysis of variance.

The p-value was found to be 0.000 from the ANOVA Test analysis. Since the p-value is less than 0.05 (0.000 < 0.05), the differences in the success of the groups affected their ability to use metacognitive strategies at the 95% significance level. In other words, we can say that the relationship between the ability to use the taught strategies and the success scores of the groups is statistically significant at the 95% significance level.

In the light of these findings, the students who have the lowest average of achievement test (such as 2-3), who have the lowest level of use of metacognitive techniques (such as 2-3), and those students who are better in terms of their degree of using metacognitive techniques (such as 3-4), follow the metacognitive techniques. It can be said that students with high usage levels (5-6) constitute the most successful group.

DISCUSSION AND CONCLUSION

When we consider the findings of our study, three sub-problems are evaluated as follows:

First sub-problem result: Before applying the teaching techniques in the study, it was statistically proved that the

knowledge levels of the experimental group and the control groups about the relevant unit were equal. A significant difference was found between the arithmetic mean of the last achievement test applied to the experimental and control groups. In the lesson taught with metacognitive strategies, the students showed more interest in the lesson, actively participated in the lesson, made comments on the subject, and thus, the experimental group students' success was higher than the control group students.

This result is based on previous studies (D'avanzo, 2003; Gelen, 2004; Conner and Gunstone, 2004; Shabaya, 2005; Yıldız and Ergin, 2007; Özsoy, 2007) in which metacognitive skills are tried to be gained to students at different and similar levels and the effectiveness of metacognitive strategies are determined (Alcı and Altun, 2007; Kılıç Çakmak et al., 2008). Supporting the results of previous studies, the results of this research and metacognitive strategies have been effective in learning the information.

Second sub-problem result: Before the teaching strategies were applied, it was proved that there was no significant difference between the experimental and control groups in terms of using metacognitive strategies. After the application, this balance was broken and a significant difference between the two groups showed that the teaching of metacognitive strategies applied to the experimental group was effective. As a result; there was a significant difference between students in classrooms where metacognitive strategies were applied and students in classrooms where traditional learning approaches were applied in terms of developing and using their metacognitive strategies.

Supporting the results of previous studies, the results of this research show that metacognitive skills can be improved through teaching (D'avanzo, 2003; Gelen, 2004; Conner and Gunstone, 2004; Shabaya, 2005; Yıldız and Ergin, 2007; Özsoy, 2007; Alcı and Altun 2007; Kılıç Çakmak et al., 2008).

Third sub-problem results: In the results of the first and second sub-problems, a significant difference was observed between the experimental and control groups, and the difference was in favor of the experimental group and was significant. However, it was thought whether this difference is related to the development in the use of metacognitive strategies. The scores obtained from the last achievement test and the last GÖS scores were found to be related according to the independent sample one-way analysis of variance.

RECOMMENDATIONS

Biology lesson gives the impression of a boring, memorized lesson to the students because it is generally presented as a set of theoretical information by teachers. For this reason, interest in biology was very low, and the desired level of teaching success could not be reached completely.

With the effect of different learning techniques that can be applied differently from traditional learning methods, the biology course should take the form of a lesson that attracts the attention of students, they observe and wonder in daily life, and where they can find many living things and events (Atılboz, 2001; Atıcı and Doğan, 2004; Akkurt, 2020).

Therefore, great attention should be paid to biology education by all countries of the world, and various methods should be developed to increase the quality of this teaching.

In many studies, the methods and techniques used as the reason for failure in all courses have been shown (Tay, 2005).

The following suggestions for the success of the biology course can be listed in the light of the findings of this study, which proves that the biology course, which is taught using metacognitive strategies, is more efficient:

- In biology teaching, in schools, new methods and techniques that are creative and interesting should be used by moving away from traditional learning methods based on memorization.
- With the teaching of metacognitive strategies, students' skills of using success and strategies increase. For this reason, metacognition can be used as a useful tool to develop the ability to identify living things, which are among the secondary education curriculum and play an important role in the development of students, and to classify them according to their characteristics. In this direction, teaching supportive of metacognitive skills should be done in all teaching processes.
- Teachers and especially prospective teachers should be equipped with knowledge and skills about using metacognitive strategies in teaching biology.

In the light of the findings of this study, which proves that biology education, which is taught by teaching metacognitive strategies, is more efficient, the following study suggestions can be listed for the success of all training:

- Examining the effect of metacognition on courses other than biology may provide useful results. In the literature review for this research, it was seen that metacognitive skills were mostly associated with language and mathematical skills. In addition, practices were generally made at the primary education level. Therefore, in light of these studies, metacognitive strategies should be studied at the secondary

education level and in different fields. Especially chemistry, physics, science, social studies, and arts fields.

- In a different study, the effect of teaching metacognitive strategies on the permanence of learning can be investigated.

- How should the secondary education program be developed to gain metacognitive knowledge and skills? The answer to the question can be searched.

Disclosure of interest

- The authors declare that they have no competing interest

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REFERENCES

Akaydın, G., and **Soran**, H. (**1998**). Liselerdeki biyoloji öğretmenlerinin derslerini deneyler ile işleyebilme olanakları. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 14(14). Retrieved from https://dergipark.org.tr/tr/pub/hunefd/issue/7823/102809.

Akkurt, N. D. (**2020**). 'Farklı Gözlerden Çevre ' isimli TÜBİTAK destekli 4004 Projesi Etki Analizi. The Journal of Academic Social Sciences DOI: 10.29228/ASOS.40267.

Alcı, B., and **Altun**, S. (**2007**). Lise öğrencilerinin matematik dersine yönelik özdüzenleme ve bilişüstü becerileri, cinsiyete, sınıfa ve alanlara göre farklılaşmakta mıdır? Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 16(1): 33-44.

Atıcı, T., and **Doğan**, N. (**2004**). Ortaöğretim kurumlarında biyoloji eğitiminde kullanılan öğretim metotlarının ders öğretmenleri açısından değerlendirilmesi ve öneriler. Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 4(2): 51-63.

Atılboz, G. N. (**2001**). Lise 1. sınıf öğrencilerinde hücre ve molekül biyoloji konuları ile ilgili görsel ve deneysel malzeme kullanımının başarı üzerinde etkisi. Gazi Üniversitesi, Ankara, Yayımlanmış yüksek lisans tezi. https://tezarsivi.com/lise-1-sinif-ogrencilerinde-hucre-ve-molekuler-biyoloji-konulari-ile-ilgili-gorsel-ve-deneysel-malzeme-kullaniminin-basari-uzerine-etkisi.

Blakey, E., and **Spence**, S. (**1990**). 'Developing Metacognition.' The Educational Resources Information Center (ERIC) Digest. ED327218 Nov 90.https://eric.ed.gov/?id=ED327218.

Conner, L., and **Gunstone**, R. (**2004**). Conscious knowledge of learning: accessing learning strategies in a final year high school biology class. International Journal of Science Education, 26(12): 1427–1443.

D'avanzo, C. (**2003**). Application of research on learning to college teaching: Ecological examples. Bioscience, 53(11): 1121-1127.

Deseote, A., Roeyers, H., and Buysse, A. (**2001**). Metacognition and mathematical problem-solving in grade 3. Journal of Learning Disabilities, 34(5): 435-449.

Doğan, A. (**2013**). Üstbiliş ve üstbilişe dayalı öğretim. Middle Eastern and African Journal of Educational Research, 3: 6-20.

Duman, Y. (**2008**). Öğrencilerin Benimsedikleri Eğitim Felsefeleriyle Kullanıldıkları Öğrenme Strateji Ve Öğrenme Stillerinin Karşılaştırılması. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 17(1): 203-224.

Flavell, J. H. (**1979**). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34(10): 906-911.

Gelen, İ. (**2004**). Bilişsel Farkındalık Stratejilerinin Türkçe Dersine İlişkin Tutum, Okuduğunu Anlama ve Kalıcılığa Etkisi XIII. Ulusal Eğitim Bilimleri Kurultayı, 6-9 Temmuz 2004 İnönü Üniversitesi, Eğitim Fakültesi, Malatya.

Güven, T., Kıvanç, E., and Yel, M. (**2001**). Lise1 Biyoloji Ders Kitabı. Paşa Yayıncılık, Ankara. https://www.nadirkitap.com/lise-1-biyoloji-ders-kitabi-turan-guven-erkut-kivanc-mustafa-yel-kitap19253373.html.

Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., Büyüköztürk, Ş., and Demirel, F. (**2008**) The Turkısh adaptation study of motivated strategies for learning questionnaire (MSLQ) for 12 to 18 year old chıldren: Results of confırmatory factor analysis. The Turkish Online Journal of Educational Technology, 7(4): Article 12.

Kuhn, D. (**2000**). Metacognitive development. Current Directions in Psychological Science, 9(5): 178-181.

Kuiper, R. (**2002**). Enhancing metacognition through the reflective use of self-regulated learning strategies. The Journal of Continuing Education in Nursing, 33(2): 78-87

Lin, X., Schwartz, D. L., and Hatano, G. (**2005**). Toward teachers' adaptive metacognition. Educatıonal Psychologist, 40(4): 245–255.

Livingston, J. A. (**2003**). Metacognition: An Overview. Educational Resources Information Center. https://eric.ed.gov/?id=ED474273.

O'Neıl, H. F., and **Abedi**, J. (**1996**). Reliability and validity of a state metacognitive ınventory: Potential for alternative assessment. The Journal of Educational Research, 8(4): 234-245.

Özsoy, G. (**2007**). İlköğretim Beşinci Sınıfta Üstbiliş Stratejileri Öğretiminin Problem Çözme Başarısına Etkisi, Doktora tezi, Ankara, G. Ü. Eğitim Bilimleri Enstitüsü.

Paris, S. G., and **Winograd**, P. (**1990**) Promoting metacognition and motivation of exceptional children. Remedial and Special Education, 11(6): 7-15.

Roebers, C. M., Kälin, S., and Aeschlimann, E. A. (**2020**), A comparison of non-verbal and verbal ındicators of young children's metacognition. Metacognition and Learning, 15(1): 31-49.

Schraw, G. (**2009**). A conceptual analysis of five measures of metacognitive monitoring. Metacognition Learning, 4: 33–45.

Schraw, G., and **Graham**, T. (**1997**). Helping giffted students develop metacognitive awerenness. Roeper Review, 20: 4-8.

Senemoğlu, N. (**2007**). Gelisim, Öğrenme ve Öğretim. Ankara: Gönül Yayıncılık ltd. Şti https://aniyayincilik.com.tr/public/assets/catalogs/0136946001530535397.pdf.

Shabaya J., (**2005**). The Role of Preservice Teachers in Developing Metacognitive Awareness Strategies in an Urban Language Arts Writing High School Classroom. College Teaching Methods and Styles Journal – Third Quarter, 1(3): 49-57.

Sperling, R. A., Howard, B. C., Staley, R., and DuBois, N. (**2004**), Metacognition and self-regulated learning constructs. Eucational Research and Evaluation, 10: 117-139.

Tay, B. (**2005**). Sosyal Bilgiler Ders Kitaplarında Öğrenme Stratejileri. Gazi Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 6(1): 209-225.

Wall, K., and **Higgins**, S. (**2006**) Facilitating metacognitive talk: A research and learning tool International Journal of Research and Method in Education, 29(1): 39–53.

Yaman, M., and **Soran**, H. (**2000**). Türkiye'de Ortaöğretim Kurumlarında Biyoloji Öğretiminin Değerlendirilmesi. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 18 (18)

Yıldız, E., and **Ergin**, Ö. (**2007**). Bilişüstü ve Fen Öğretimi. Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi, 27(3): 175-196.

Yurdakul, B., and **Demirel**, Ö. (**2011**). Yapılandırmacı Öğrenme Yaklaşımının Öğrenenlerin Üstbiliş Farkındalıklarına Katkısı. Uluslararası Eğitim Programları ve Öğretim Çalışmaları Dergisi, 1(1): 71-85.

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